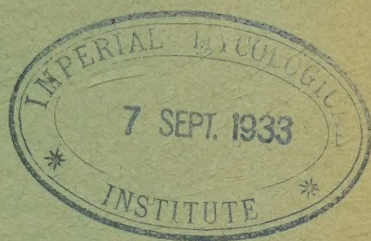


RUBBER RESEARCH INSTITUTE

OF

MALAYA



ANNUAL REPORT 1932



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August 1933

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THE RUBBER RESEARCH INSTITUTE of MALAYA

Members of the Board AUGUST, 1933

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Mr. G. WISEMAN		Nominated by the High Commissioner for the Malay States to represent the planting industry of the Straits Settlements
{ virtute officii	The Director of Agriculture, S.S. & F.M.S.	Appointed by Enactment
	The Secretary to the High Commissioner for the Malay States	Nominated by the High Commissioner for the Malay States to represent the States of Johore, Kedah, Kelantan, Trengganu and Perlis
	The Treasurer, F.M.S.	Financial Officer nominated by the High Commissioner for the Malay States

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Mr. C. B. GRABURN, J.P.

Mr. A. P. CRANNA
Mr. K. ARUMUGAM

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The Director, R.R.I., Chairman

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The Director, R.R.I.

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The Director, R.R.I.

RUBBER RESEARCH INSTITUTE OF MALAYA.

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PUBLICATIONS.

Publications of the Rubber Research Institute are issued in the following forms:—

- (1) *Planting Manuals* appearing at irregular intervals at a price to be fixed for each number.
- (2) *Bulletins* appearing occasionally at a price to be fixed for each number.
- (3) *Journal R.R.I.* appearing at irregular intervals each year.

The following publications have been issued and copies can be obtained on application at the prices given against each:—

Bank commission should be added to outstation cheques.

- | | | | |
|---|--|----------------|--------|
| (a) Planting Manuals. | | | |
| No. 1, "Preparation of Plantation Rubber" | by B. J. Eaton | ... | \$2.00 |
| No. 2, "Budding of Hevea in Modern Plantation Practice" | by F. Summers | ... | \$2.00 |
| No. 3, "Plantation Sheet Rubber Manufacture" | by R. O. Bishop | ... | \$2.00 |
| No. 4, "Latex Preservation and Shipment" | by R. O. Bishop and R. G. Fullerton | ... | \$2.00 |
| No. 5, "The History and Description of clones of Hevea Brasiliensis" | by C. E. T. Mann and C. C. T. Sharp. Illustrated by H. C. Chuan. | ... | \$2.00 |
| (b) Journal of the R.R.I., Vol. 1, Nos. 1 and 2 | ... | ... | \$1.00 |
| Separate copies of other numbers | ... | ... (each) | 0.50 |
| (c) Annual Reports from 1928 | ... | ... | \$1.00 |
| (d) Bulletin No. 1. | | | |
| "Natural Coagulation of Hevea Latex" | by A. S. Corbet | | \$1.00 |
| Bulletin No. 2. | | | |
| "A Study of the effect of Damp Storage on Raw Rubber" | by B. J. Eaton and R. G. Fullerton | ... | \$1.00 |
| Bulletin No. 3. | | | |
| "The Root Disease Problem on Old Rubber Areas in Malaya" | by A. Sharples and A. R. Sanderson | ... | \$1.00 |
| Bulletin No. 4. | | | |
| "Summary of Meteorological Records, Soils Division" | by W. B. Haines | ... | \$1.00 |
| (e) Information Cards, dealing with various phases of Rubber Estate Factory Practice and Defects in Raw Rubber. | | | |
| —Cards free. Loose-leaf stiff cover in which cards are enclosed | | in Malaya | 0.50 |
| | | outside Malaya | \$1.00 |

REPORT OF THE BOARD

FOR THE

YEAR ENDED 31st DECEMBER, 1932

INAUGURATION OF THE INSTITUTE

A provisional Board appointed by the Government of the Federated Malay States held its first meeting on the 6th February, 1925 ; later in 1925 the Board of the Rubber Research Institute of Malaya was incorporated by "The Rubber Research Institute of Malaya Enactment, 1925," which came into force on the 1st September, 1925.

The present site of the offices and laboratories was leased to the Board for a period of ten years as from the 1st March, 1926. The first Director of the Institute assumed duty at the end of September, 1926, from which time the active life of the Institute may be dated ; the work of the Institute has therefore been in progress for approximately 6½ years.

BOARD OF CONTROL

At the 31st December, 1932, the Board comprised :

- (a) The Director of Agriculture, S.S. & F.M.S.
(H. A. Tempany, D.Sc., F.I.C., F.C.S.)
- (b) a member nominated by the High Commissioner for the Malay States to represent the States of Johore, Kedah, Kelantan, Trengganu and Perlis,
The Secretary to the High Commissioner
(Mr. E. E. F. Pretty, M.C.S.)
- (c) a financial officer nominated by the High Commissioner for the Malay States,
The Treasurer, F.M.S.
(The Hon'ble Mr. M. Rex, M.C.S., M.F.C.)
- (d) a member nominated by the High Commissioner for the Malay States to represent small-holders,
Che Hamzah bin Abdullah, M.C.S.
- (e) a member nominated by the High Commissioner for the Malay States to represent the planting community of the Straits Settlements,
Mr. G. Wiseman

- (f) two members appointed by the Rubber Growers' Association,
Mr. C. B. Graburn, J.P.
Mr. A. P. Cranna
- (g) two members appointed by the Planters' Association of
Malaya,
Mr. E. N. T. Cummins
The Hon'ble Mr. H. B. Egmont Hake, M.F.C.
- (h) two members appointed by the Malayan Estate Owners'
Association,
Mr. K. Arumugam
Mr. R. M. E. Michaux

It is with deep regret that the Board records the death in Bungsar Hospital, Kuala Lumpur, on the 18th August, 1932, of the Hon'ble Mr. J. S. Arter, M.F.C., who attended the first meeting of the Board early in 1925 and who had served on the Board from that time up to the day of his death.

Mr. F. W. South, Acting Director of Agriculture S.S. & F.M.S., was President of the Board until the return in February of Dr. Tempany who, while on leave, had been re-elected to that office.

Mr. C. B. Graburn was re-appointed by the Rubber Growers' Association to serve on the Board for a further period of three years from the 7th August, 1932.

Mr. A. P. Cranna was appointed by the Rubber Growers' Association to serve on the Board in place of the late Mr. Arter, as from the 6th October, 1932.

Mr. E. N. T. Cummins, an appointee of the Planters' Association of Malaya returned from leave and resumed his seat on the Board as from the 6th September, 1932, displacing Mr. R. S. Chantler.

The Hon'ble Mr. H. B. Egmont Hake, an appointee of the Planters' Association of Malaya, was on leave from the 18th March to the 13th October, 1932. During his absence the Association appointed the Hon'ble Mr. B. J. R. Barton to serve on the Board.

Mr. R. M. E. Michaux, an appointee of the Malayan Estate Owners' Association was on leave from the 29th February to the 17th May, 1932, during which period the Association appointed Mr. W. A. Stanton to serve on the Board.

On the 1st February, 1932, the High Commissioner for the Malay States nominated, by virtue of section 4 (ii) of "The Rubber Research Institute of Malaya Enactment, 1925," Mr. G. Wiseman to the Board to represent the planting community of the Straits Settlements. Mr. Wiseman was on leave from the 11th May to the 13th November, 1932, during which period Mr. P. M. Williams was nominated to serve on the Board.

BOARD AND COMMITTEE MEETINGS

During the year 1932 Board and Committee meetings as under were held :—

Board—ordinary meetings	... 5
Board—special meetings	... 4
Executive Committee	... 13
Finance Committee	... 6
Experiment Station Committee	... 6
Rubber Roadways Committee	... 5
Research Committee	... 3
Retrenchment Committee	... 4
Other ad hoc Committees	... 2
	48

In April the Board appointed a Retrenchment Committee to examine and report upon the organisation with a view to a reduction in the expenditure of the Institute. As a result of the Committee's recommendations the Board was able to effect a considerable reduction in the estimated expenditure for 1933.

A further result of the Retrenchment Committee's work was the merging of the Finance Committee and the Experiment Station Committee into the Executive Committee, the effect of which is that the Board is now assisted in its work by only three standing Committees, namely, the Executive Committee, the Research Committee and the Rubber Roadways Committee.

The Research Committee has laid the foundations of several comprehensive research programmes and experiments, references to which will be found in the Director's and the Divisional reports.

The Rubber Roadways Committee has given considerable attention to the question of the laying of large-scale plots of road surfacing materials containing rubber or latex, and has for this purpose obtained from the Rubber Experimental Research & Propaganda Advisory Board a first instalment of \$10,000 of a grant made from the Propaganda Fund. It is anticipated that it will be possible to proceed with the laying of different 'type' plots on streets in Kuala Lumpur during the first half of 1933.

In January, 1932, the negotiations begun in 1931 for the amalgamation of the London Advisory Committee of the Rubber Research Institute of Malaya and the London Advisory Committee of the Rubber Research Scheme (Ceylon) were brought to a conclusion by a combined meeting of the two Committees and the formation of the London Advisory Committee for Rubber Research (Ceylon & Malaya). The technical work of the Committee is being done at

the Imperial Institute, London, and as a result closer co-ordination of the work in Malaya, London and Ceylon is anticipated.

REVENUE OF THE INSTITUTE

The revenue of the Institute is obtained by (a) a cess of 10 cents a pikul of rubber exported from the Federated Malay States, Kedah, Kelantan and Trengganu, (b) a contribution by the Straits Settlements Government at the rate of 10 cents a pikul of rubber which it is calculated has been produced in and exported from the Colony, (c) a contribution of \$50,000 from the State of Johore. The cess was not collected in the years 1925 to 1928, during the period that exports of rubber were controlled by the Rubber Restriction Enactment, but the Administrations concerned made payments out of general revenue. Since 1930 the Administrations in category (a) have agreed, for convenience of collection of the cess, to impose a special export duty under their Customs Enactments.

During the year the Board gave consideration to the question of reducing the cess and decided that when the position became clearer a recommendation would be made.*

The subjoined table shows the revenue of the Institute since its inception :—

	F.M.S	Kedah	Kelantan	Trengganu	Johore	Straits Settlements	Total
Prior to 1925 ...	130,664	15,750		1,649	37,500	32,805	218,368
1925 Sep-Dec.	81,020	7,000		608	16,667	14,580	119,875
1926 ...	269,145	21,000	7,837	2,881	50,000	60,705	411,568
1927 ...	214,371	21,000	9,837	3,002	50,000	48,540	346,750
1928 ...	293,078	21,000	9,603	2,820	50,000	65,942	442,443
1929 ...	438,609	21,000	13,733	3,714	50,000	95,000	622,056
1930 ...	419,469	46,386	11,972	3,355	50,000	76,591	607,773
1931 ...	405,158	67,116	9,821	3,128	50,000	76,591	611,814
1932 ...	396,526	65,581	8,708	3,053	50,000	50,288	574,156
Totals ...	2,648,040	285,833	71,511	24,210	494,167	521,042	3,954,803
Percentages ...	67.0	7.2	1.8	0.6	10.2	13.2	

*The cess has since been reduced to 8 cents for a period of eleven months from the 1st February, 1933.

The following statement shows the quantity of rubber estimated to have been exported from the F.M.S. and the U.M.S., and produced in and exported from the Straits Settlements, for each year from 1929 to 1932.

	F.M.S.	Kedah	Kelantan	Trengganu	Johore	Straits Settlements	Perlis	Total
	tons	tons	tons	tons	tons	tons	tons	tons
1929 ...	261,353	39,298	8,042	2,212	89,296	50,061	291	450,553
1930 ...	250,122	38,303	7,375	1,998	90,639	45,590	266	434,293
1931 ...	244,149	40,290	6,593	1,860	90,778	29,993	196	413,859
1932 ...	235,892	39,044	5,171	1,817	86,686	36,440	159	405,209
Totals ...	991,516	156,935	27,181	7,887	357,399	162,084	912	1,703,914
Percentages ...	58.2	9.2	1.6	0.45	21.0	9.5	0.05	

ACCOUNTS FOR THE YEAR 1932

Appended are the Income and Expenditure account for the year 1932 and the Balance Sheet as at the 31st December, 1932.

From the former it will be seen that the total cess collected and to be collected from producers of rubber, together with the contributions from the State of Johore and from the Colony of the Straits Settlements, amounted to \$565,850.21 for the year 1932 and \$3,955.75 under-estimated in 1931; miscellaneous receipts were \$11,447.13. The total recurrent expenditure was \$503,840.79 and the capital expenditure \$11,932.90. In addition a sum of \$3,019.30 was expended on rubber roadway trials from a grant of \$10,000 from the Rubber Experimental Research and Propaganda Fund, leaving an unexpended balance in this account of \$6,980.70.

From the balance sheet it will be observed that the excess of assets over liabilities is shown as \$1,269,618.04, which is represented by :

Land, Buildings and Furniture to the value of ...	\$ 501,113.17
Plant, Machinery and Apparatus " " ...	61,671.27
Expenditure on Experiment Station development	453,535.33
Stocks ...	2,003.32
Sundry debtors, including cess to be collected ...	88,709.04
Investments ...	64,744.62
Cash ...	155,035.41
	\$1,326,812.16
Less sundry creditors ...	57,194.12
	\$1,269,618.04

THE DIRECTOR OF THE INSTITUTE

The Director of the Institute, Lt.-Col. B. J. Eaton, O.B.E., F.I.C., F.I.R.I., F.C.S., was on leave from the 14th May, 1932, to the end of the year, during which period Mr. A. Sharples, A.R.C.S., D.I.C., head of the Pathological Division, acted as Director.

E. N. T. CUMMINS

President of the Board

Kuala Lumpur

28th March, 1933

STATEMENT OF ACCOUNTS

FOR YEAR ENDED

31ST DECEMBER, 1932

THE RUBBER RESEARCH

INCOME AND EXPENDITURE ACCOUNT

EXPENDITURE					
		\$	c.	\$	c.
To Experiment Station	...			44,304	12
„ Board and Committees Fees and Ex-	...				
penses	...			6,537	72
„ London Research Expenses	...			12,796	02
„ Salaries and Allowances	...			238,598	90
„ Provident Fund Contributions	...			11,846	10
„ Staff Leave and Passages	...			42,963	50
„ Rubber Roadways Research	...			18,699	55
„ Rubber Roadways Trials	...			3,019	30
„ Medical	...			2,466	15
„ Travelling	...			11,240	86
„ Office—Printing, Stationery, Postage, Tele-	...				
phones, Audit, Legal, etc.	...			6,903	29
„ Rents, Rates and Insurance	...			6,989	52
„ Laboratory General Charges	...			1,190	17
„ Buildings, Upkeep	...			3,082	97
„ Furniture, Upkeep	...			828	11
„ Laboratory Grounds, Upkeep	...			523	21
„ Plant and Machinery—					
Upkeep	...		700 83		
Running	...	6,636	10	7,336	93
„ Lorry—Running	...			1,946	28
„ Workshop—Upkeep	...			28	72
„ Laboratory Apparatus and Glassware—					
Upkeep	...			3,907	97
„ Laboratory Chemicals	...			2,730	06
„ Publications—Printing and Distributing	...			10,774	72
„ Books and Periodicals—					
Purchase and Subscriptions	...	3,147	71		
Sundry Expenses	...	546	03	3,693	74
„ Exhibitions and Shows	...			2,174	37
„ Rural Lecture Caravan—					
Proportion of Expenses	...			1,654	06
„ Field Experiments	...			6,235	48
„ Contingencies	...			1,442	92
„ Depreciation	...			52,945	35
				506,860	09
„ Balance—Excess of Income over Expen-	...			80,437	25
diture—carried down	...				
				\$ 587,297	34
To Excess of all Income over Expenditure	...				
carried to Balance Sheet	...			84,393	00

(Sgd.) H. S. BLACKLIN

Secretary

Kuala Lumpur, 6th February, 1933

\$ 84,393 00

INSTITUTE OF MALAYA

FOR YEAR ENDED 31st DECEMBER, 1932

INCOME		\$	c.	\$	c.
By Cess collected and Contributions by Administrations				522,529	61
„ Cess and Contributions by Administrations outstanding—Estimated	...			43,320	60
„ Miscellaneous Receipts—					
Bank Interest and accrued Interest on Investments		5,174	13		
Profit on sale of 5% British War Loan	...	3,135	32		
House rentals		886	17		
Sales of Rubber, Budwood, etc	...	453	01		
Sales of Publications		1,798	50	11,447	13
„ Rubber Experimental Research and Propaganda Advisory Board:					
First instalment of grant for Rubber Roadways Trials				10,000	00
				\$ 587,297	34
By Excess of income over expenditure brought down				80,437	25
„ Collections & contributions by administrations under-estimated in 1931	...			3,955	75
				\$ 84,393	00

THE RUBBER RESEARCH

BALANCE SHEET AS

LIABILITIES								
	\$	c.	\$	c.	\$	c.	\$	c.
SUNDRY CREDITORS :								
at Experiment Station	...		...		1,739	26		
travelling Claims of Staff	...		...		954	38		
sundry Other Creditors	...		...		5,715	81	8,409	45
DEPOSITS :								
for future Publications	...		...				189	90
RESERVES :								
Staff Leave Pay								
at 1st January 1932	60,182	98						
add Reserve for year	28,340	00	88,522	98				
less Paid during year	...		55,091	13	33,431	85		
Staff Passages								
at 1st January 1932	16,141	12						
add Reserve for year	12,077	00	28,218	12				
less Paid during year	...		13,573	95	14,644	17		
					48,076	02		
Experiment Station	...		...		518	75	48,594	77
EXCESS OF ASSETS OVER LIABILITIES								
balance at 1st January 1932	...		...		1,185,225	04		
add Excess of all income over								
Expenditure for year			...		84,393	00	1,269,618	04

Carried forward ... 1,326,812 16

INSTITUTE OF MALAYA

AT 31st DECEMBER, 1932

ASSETS							
		Depreciation for year					
	\$	c.	\$	c.	\$	c.	\$ c.
LAND AND BUILDINGS:							
132 Ampang Road							
Land as at 1st Jan. 1932	...		...		10,755	00	
Ampang Villa as at 1st January 1932	...	17,774 11	507 83		17,266	28	
132a Ampang Road							
Building as at 1st January 1932	...	40,402 15	1,154 34		39,247 81		67,269 09
Land behind Ampang Villa							
as at 1st January 1932	...		...		5,033	35	
less refund of Survey Fees	...		...		4 00		5,029 35
5 Circular Road							
Land as at 1st Jan. 1932	...		...		17,147	08	
Old Building as at 1st January 1932	...	13,844 35	395 55		13,448	80	
3 Houses as at 1st January 1932	...	73,119 93	2,089 14		71,030 79		101,626 67
163 Ampang Road							
Land as at 1st Jan. 1932	...		...		31,440	35	
Old Building as at 1st January 1932	...	12,855 64	267 30		12,488	34	
First Five Houses as at 1st Jan. 1932	...	86,180 66	2,462 30		83,718 36		127,647 05
3½ Mile, Ampang Road							
Land as at 1st Jan. 1932	...		...		45,422	50	
Second Five Houses as at 1st Jan. 1932	...	78,288 36					
less Additions not made written back		66 11					
		78,222 25	2,124 89		76,097 36		121,519 86
LABORATORY BUILDINGS:							
as at 1st Jan. 1932	...	45,868 71	11,467 18				34,401 53
PLANT AND MACHINERY:							
Electric Plant							
as at 1st January 1932	...	4,099 29	1,024 82		3,074	47	
General Machinery							
as at 1st January 1932	...	17,224 30	2,583 65		14,640 65		17,715 12
FURNITURE:							
Residential Houses							
as at 1st January 1932	...	32,785 80	2,448 94		30,336	86	
Office							
as at 1st January 1932	...	10,887 46	816 56		10,070	90	
Laboratory							
as at 1st January 1932	...	2,039 96					
add Additions during year	...	252 75					
		2,292 71	171 95		2,120	76	
Store							
as at 1st January 1932	...	196 91	14 77		182	14	
Carried forward	...		27,629 22		42,710 66		475,208 67

BALANCE SHEET AS

 LIABILITIES—(cont.)

	\$	c.	\$	c.	\$	c.	\$	c.
Brought forward							1,326.81	16

Carried forward ...	...	...	...	...	1,326.81	16
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ASSETS—(cont.)									
		Depreciation for year.							
	\$	c.	\$	c.	\$	c.	\$	c.	
Brought forward ...			27,629	22	42,710	66	475,208	67	
Library									
as at 1st January 1932 ...	809	91							
add Additions during year ...	172	75							
	982	66	73	70	908	96	43,619	63	
LABORATORY EQUIPMENT AND APPARATUS :									
as at 1st January 1932	47,884	86							
add Additions during year ...	4,086	90							
	51,971	76							
less Sale of microtome	30	00							
	51,941	76	10,343	95			41,597	81	
MOTOR LORRY :									
as at 1st January 1932	501	25							
add Cost of new lorry	2,041	00							
	2,542	25							
less Sale of old lorry	200	00							
	2,342	25	811	50			1,530	75	
WORKSHOP EQUIPMENT :									
as at 1st January 1932	973	63	146	04			827	59	
R.R.I. EXPERIMENT STATION :									
Development Expenditure as at 1st January 1932 ...	461,866	77							
add Survey fees and premium ...	5,609	50							
	467,476	27	13,940	94			453,535	33	
Total Depreciation written off during year ...			\$52,945	35					
LIBRARY BOOKS AND PERIODICALS :									
as at 1st January 1932 ...					1	00			
add Purchases during year ...					3,147	71			
					3,148	71			
less written off during year ...					3,147	81		1	00
STOCK IN HAND :									
Petrol and Oil :									
Laboratory ...			145	81					
Experiment Station ...			19	92	165	73			
Petrol Empties and Gas cylinders :									
Laboratory ...			110	00					
Experiment Station ...			68	50	178	50			
Stationery ...					683	37			
Sundry Materials									
Laboratory ...			272	79					
Experiment Station ...			701	93	974	72	2,002	32	
Carried forward ...							1,018,923	09	

BALANCE SHEET AS

LIABILITIES—(cont.)

	\$	c.	\$	c.	\$	c.	\$	c.
Brought forward ...		...		...			1,326,812	16

(Sgd.) E. N. T. CUMMINS

President

10th February, 1933

\$1,326,812 16

I hereby certify that to the best of my knowledge and belief
Kuala Lumpur

20th January, 1933

We have audited the above Balance Sheet and Income and
Research Institute and certify same to be correct according to the
by the books of the Institute.

Kuala Lumpur,

26th January, 1933

AT 31st DECEMBER, 1932

ASSETS—(cont.)								
	\$	c.	\$	c.	\$	c.	\$	c.
Brought forward ...	...	...	...	...			1,018,323	09
PAYMENTS IN ADVANCE:								
Against Subscriptions for 1933 ...	...	...	...	...	7	45		
„ Leave Pay ...	...	...	...	...	150	00	157	45
SUNDRY DEPOSITS:								
Against Water Supply, Telephone, etc.	...	...	...	...				
Laboratory ...	...	...	...	...	270	00		
Experiment Station ...	...	...	...	...	20	00	290	00
ADVANCES TO STAFF FOR MOTOR CARS, ETC:								
Senior Staff ...	...	...	...	...	3,060	11		
Junior Staff ...	...	...	...	...	478	00	3,538	11
SUNDRY DEBTORS:								
F.M.S. Government ...	...	...	66,155	77				
Kedah Government ...	...	...	6,403	60				
Kelantan Government ...	...	...	700	00				
Trengganu Government ...	...	...	1,400	00	74,659	37		
At Experiment Station ...	...	...	...	...	326	87		
Sale of Publications ...	...	...	...	...	95	44		
Sundry other debtors ...	...	...	...	...	1,674	73	76,756	41
LOAN TO R.R.I. PROVIDENT FUND ...								7,967 07
INVESTMENTS:								
F.M.S. Government 4½% Loan	...	...	...	...				
Nominal value \$65,000/- ...	...	...	...	...			64,744	62
CASH AT BANK AND IN HAND:								
London Advisory Committee for Rubber Research (Ceylon and Malaya) ...	...	...	...	...	971	35		
Chartered Bank, London ...	...	...	...	...	858	91		
Chartered Bank, Kuala Lumpur	...	...	...	...				
Board's Account ...	...	...	86,158	56				
Working Account ...	...	...	17,689	32				
Experiment Station ...	...	...	1,369	95	105,217	83		
Mercantile Bank, Kuala Lumpur	...	...	...	...				
Board's Account ...	...	...	...	...	47,803	13		
Petty Cash	...	...	...	...				
Laboratory ...	...	...	27	50				
Experiment Station ...	...	...	156	69	184	19	155,035	41
								\$1,326,812 16

all liabilities to 31st December, 1932, have been brought into account.

(Sgd.) H. S. BLACKLIN
SecretaryExpenditure Account with the books and vouchers of the Rubber-
best of our information and explanations given us and as shown(Sgd.) GIBSON, ANDERSON, BUTLER & CO
Chartered Accountants-
Auditors

ANNUAL REPORT

BY

THE DIRECTOR

Introduction

The year 1932 constitutes the sixth complete year of the Institute's existence. As in previous years, the advisory work of the Institute has been considerable and, especially in the Chemical Division, has interfered with research investigations, in spite of various methods adopted to systematise reports sent out and the issue of Information Cards in respect of a number of stereotyped enquiries on various defects of raw rubber, methods of preparation, preservation of latex and other problems.

It must be realised however that the publication of the results of certain investigations in relation to estate practice is bound to increase the number of such enquiries over a considerable period. This is particularly evident in respect of two publications by the Chemical Division during 1931 and 1932, viz. a Manual (No. 3) on Plantation Sheet Rubber Manufacture and a Manual (No. 4) on Latex Preservation and Shipment.

In both instances and also on account of the increased interest of producers during 1932 in the export of latex, numerous enquiries relating to particular problems on the individual estate have been received necessitating not only additional correspondence but in many cases visits to the estates concerned.

This is an inevitable result of the publication of all new investigations, especially those having a bearing on problems of immediate importance, more especially at the present time when producers are making every effort to economise on cost of production or to export rubber in the form of latex, on account of the higher market value of the latter compared with that of raw rubber in the form of sheet or crepe.

Staff

Owing to leave exigencies and retrenchment, the staff on duty during the year has been considerably depleted.

The Director proceeded on leave on the 13th May and was absent for the remainder of the year.

Mr. A. Sharples, Head of the Pathological Division was appointed by the Board to act as Director.

BOTANICAL DIVISION

Mr. C. E. T. Mann, Head of the Division reported his return from leave and assumed duty on the 7th February.

Mr. L. E. Morris proceeded on leave on the 4th March and as a result of the retrenchment proposals, his services were dispensed with at the expiry of his leave.

CHEMICAL DIVISION

Mr. R. O. Bishop was in charge of the Division till he proceeded on leave on the 1st October.

Dr. E. Rhodes returned from leave on the 7th February, and was appointed to act as Head of the Division during the absence of Mr. R. O. Bishop.

Dr. R. G. Fullerton resigned his appointment with effect from the 1st August.

PATHOLOGICAL DIVISION

Dr. A. S. Corbet, Bacteriologist, was absent on sick leave from 29th March till 5th June. As a result of the retrenchment proposals his services were terminated with effect from the 1st August.

Mr. F. Beeley returned from leave and assumed duty on the 22nd April.

Dr. Corbet and Mr. Beeley acted as joint Heads of the Pathological Division from 14th May till 31st July, after which Mr. Beeley continued to act as Head of the Division for the remainder of the year.

SOILS DIVISION

Dr. C. F. Flint proceeded on leave on the 13th February and, as a result of the retrenchment proposals, his services were dispensed with at the expiry of his leave.

Mr. T. S. Anantharama Iyer's (Assistant Soils Chemist) services were dispensed with under the retrenchment proposals with effect from the 1st August.

FIELD DIVISION

Mr. G. Davidson, who was allocated as Field Officer, Kedah, Province Wellesley, Kelantan and Trengganu assumed the duties of this post on the 2nd January. Under the retrenchment proposals, his services were dispensed with and he left on the 1st August.

Mr. F. Billington was also retrenched and left the Institute on the 1st August.

Mr. N. C. Jenkins, Field Officer, Johore, who was on leave at the beginning of the year, was retrenched on the expiry of his leave.

EXPERIMENT STATION

Mr. H. W. Foston, Manager, proceeded on leave on the 13th March, and returned and assumed duties on the 12th October.

Mr. H. G. W. Mathews was appointed to act as Manager during the absence on leave of Mr. Foston. Mr. Mathews's services were dispensed with as a result of retrenchment with effect from 31st October.

Mr. J. L. K. Brown was appointed to act temporarily as Assistant from 1st March to 12th October.

Mr. D. S. Gardner, Visiting Agent, returned from leave on the 6th February, and continued his services as Visiting Agent.

SECRETARY

Mr. V. L. Cachemaille proceeded on leave on the 29th March, and as a result of the retrenchment proposals his services were terminated on the expiry of his leave.

Mr. H. S. Blacklin was appointed to act as Secretary during the absence of Mr. Cachemaille and was confirmed in the appointment on the 25th October.

JUNIOR & CLERICAL STAFF

A number of members of the Junior and Clerical staff were also retrenched.

Advisory Work and "Consumption" Research

Although, as has been stated, an increase in advisory work is often inevitable as the result of the publication of new investigations or in relation to problems arising from new developments, such as the extended and increased export of latex, it is desirable that we do not lose sight of the importance of the more fundamental work, the results of which may not have an immediate influence on the industry.

In regard to research on consumption of rubber in particular, it is realised that only in certain directions can the Institute be of assistance, since many of the problems relating to new or extended uses of rubber must be investigated by those in close

contact with the particular industry in which the raw material is to be applied.

Thus the application of latex to textiles necessitates a considerable knowledge of the textile industry and close contact of investigators with that industry. Apart from certain fundamental investigations on latex or raw rubber in respect of the non-caoutchouc constituents, changes which may occur in the raw product due to natural variations in environment, climate, soils and other factors such as storage, the Institute must rely on the reports of difficulties experienced in the behaviour of the product in its particular applications and endeavour to elucidate the causes of such variation in behaviour. Secondly, it is essential not to curtail too extensively research on production in relation either to soil or disease problems on existing areas of mature rubber or investigations to which we are already committed in respect of the cultivation and treatment of improved planting material. Further, the staff employed on botanical, soils and disease problems cannot necessarily undertake the investigations required in respect of the extended utilisation of the raw product.

There appears to be some confusion on these points which requires clarification. Fundamental work however on the composition of latex and changes caused by environmental or other factors, and the physiology of latex production, as envisaged in the recent programmes of research of the Botanical and Chemical Divisions, are essential as a basic study leading to the possible further applications of the raw product.

The work on root diseases of the rubber tree is providing valuable information in relation to treatment both on mature and young rubber, which will enable estates in the future to avoid much of the expense and many of the losses which have occurred in the past and which are still occurring.

During the year 6,186 letters were received and 5,116 letters and reports were despatched dealing with enquiries. In addition, advice was given to numerous planters who visited the Institute and the Experiment Station and by members of the staff during visits to estates.

The principal enquiries are indicated in the following summary:—

Budding and Selection	...	689
Tapping	...	340
Cultivation and Cover Crops and Manuring	...	288
Diseases and Pests	...	654
Estate Factory Practice	...	937
Latex Samples Examined	...	2002
Latex Preservation and Concentration	...	876

A detailed summary for each Division is given as an appendix to the report of the Director, in order to facilitate reference.

Field Officers were allocated to Johore and Kedah during the year. The duties of the Field Officer, Johore, include visits to Singapore and Southern Malacca when necessary. The duties of the Field Officer, Kedah, who was stationed on Caledonia Estate, Province Wellesley, since no suitable accommodation was available in Kedah, included in addition visits and advice to estates in Province Wellesley, northern Perak and in the States of Kelantan and Trengganu.

Owing to retrenchment the services of the Field Officer allocated to Kedah were dispensed with in August. It was also decided to withdraw the Field Officer allocated to Johore, who was transferred to Headquarters early in 1933. At the end of the year there was only one Field Officer remaining on the staff.

Arrangements have now been made to enable visits to estates to be paid by the staff of the Research Divisions and it is hoped to economise both in time and expense by arranging definite tours to include a large number of estates. The co-operation of State and District Planters' Associations and estate managers is essential in making such tours a success.

LIAISON AND CO-OPERATION WITH OTHER INSTITUTIONS

Liaison has been continued with the Department of Agriculture and the Co-operative Societies Department.

It is to be regretted however that the efforts made by the Co-operative Societies Department for the formation of co-operative rubber factories and smoke houses for small holders in various districts have not proved to be very successful, so that it is difficult to effect any marked improvement in the product prepared on small holdings, which in many cases leaves much to be desired and which results in loss to the small producer.

The Director of the Institute has continued to be a member of the Advisory Committee, the Publications' Committee and the Agricultural Pests Advisory Committee of the Department of Agriculture and of the Film Propaganda Committee of the Co-operative Societies Department.

Contact by correspondence has also been maintained with the Rubber Research Scheme, Ceylon, the A.V.R.O.S. Proefstation in Sumatra and the Rubber Proefstation in Java. Valuable interchange of correspondence has also taken place with the Director of the Research Association of British Rubber Manufacturers.

RURAL LECTURE CARAVAN

The Rural Lecture Caravan, operated jointly by the Co-operative Societies Department, S.S. & F.M.S., the Department of Agriculture, S.S. & F.M.S. and this Institute has continued to function satisfactorily during the year. Nine tours were undertaken including Perak, Selangor, Negri Sembilan, Pahang, Penang and Province Wellesley, Malacca and Dindings.

The reports received indicate that useful work is being accomplished and that this method of propaganda is valuable in enabling advice to be disseminated among small holders, who cannot be reached satisfactorily by other methods.

CO-OPERATION WITH LONDON ADVISORY COMMITTEE RESEARCH LABORATORY

Advantage is now being taken of the new arrangements whereby collaboration has been effected with the Rubber Research Scheme, Ceylon, in the work undertaken at the Rubber Research Laboratories at the Imperial Institute.

Both the Rubber Research Institute and the Rubber Research Scheme, Ceylon, are sharing equally the cost of this work, which is carried out under the direction of Mr. G. Martin, and supervised by the London Advisory Committee for Rubber Research (Ceylon and Malaya) which is now functioning as a joint Committee in relation to rubber research on behalf of both Ceylon and Malaya.

In future, samples on which it is considered necessary to have reports made in England will be sent to these laboratories and advice obtained on matters which cannot be dealt with locally. During his leave, the Director was able to discuss various problems of interest with Mr. Martin and the Secretary and there is every reason to consider that satisfactory liaison and collaboration will be effected, especially by direct correspondence between the Director of the Institute and the Head of the Chemical Division with the Superintendent of the laboratories in London.

As far as possible also we shall endeavour to comply with requests for special samples required for work in London on certain problems which can be more effectively investigated in conjunction with manufacturers.

In view of the fact that the Rubber Growers' Association is now undertaking various special investigations in relation to new uses for rubber, it is anticipated that our assistance will be invoked from time to time in connection with such work, although generally this work is of such a character that it is essential to carry out most of the investigations in close contact with the particular industries to which the rubber is being applied. Certain types

of raw rubber and possibly latex treated in a particular manner may be necessary for such investigations and it is in this direction that the co-operation of the Institute can be visualized. In any case it is desirable that we should maintain as close contact as possible with the progress of these investigations.

A special technical sub-committee of the Rubber Growers' Association has been formed to supervise these investigations which are being carried out by a number of research workers in England.

Soil Investigations

Owing to the continuation of the depressed conditions in the industry, which have become accentuated during the year, as a result both of general world trade conditions and the surplus stock of raw rubber on the world's markets, which so far has not been diminished by any marked decrease of output, many experiments on estates in relation particularly to the application of fertilizers have been abandoned. A number of such trials, carried out under the auspices of the staff of two firms interested in the sale of fertilizers have been continued and contact is maintained with this work.

While it is still recognised that the application of fertilizers to old rubber areas may be of value in improving vegetative vigour and eventually yields, the application of fertilizers at the present market value of rubber is definitely uneconomic.

This situation has directed attention to other methods of soil improvement on impoverished areas which might be more economical.

In this connection interest has been maintained in the so-called "Forestry Method" of cultivation which has been discussed from various points of view in the local Press and in the Institute journal.

Dr. Haines has delivered several lectures on the subject to various branches of the Incorporated Society of Planters and has summarised the views of the Institute in his annual report.

Special attention is being paid at present to the ecological aspects of the problem in relation to the most suitable types of natural cover and numerous plant specimens have been received for identification and for an opinion on their suitability. We are indebted to the Director of the Botanic Gardens Singapore for the identification of a number of these plants. It is hoped shortly to have a number of plots on different soils on various estates, together with controls, on which a more detailed and intensive study of the effect of certain natural covers can be made.

At the Institute Experiment Station, a definite retardation of growth of the rubber trees has occurred on the area allowed to grow up in secondary jungle from the commencement of planting. A portion of this area has now been cleared and will be kept clean weeded in order to ascertain what increase in growth, if any, occurs on this plot. Another portion of the area is slashed twice yearly, although so far this method of treatment has not reduced the retardation of growth of the rubber trees.

There is no doubt as to the value of some type of cover during the first few years of the life of a rubber estate, until the rubber trees have established sufficient shade to protect the soil from both erosion and the deterioration caused by the rapid loss of humus after the jungle is felled and the soil is exposed.

Subsequently other factors have to be considered, especially the question of panel diseases such as Mouldy Rot, the incidence of which is increased by the damp conditions caused by the presence of undergrowth.

The continued existence of undergrowth however in mature rubber, on an area which has been well protected during the initial stages of growth, is problematical and may be quite unnecessary.

The regeneration of soils especially on deteriorated hilly land by the controlled growth of suitable natural covers is also a separate and distinct problem. There is little doubt that soil improvement can be effected by the adoption of such methods, although on some areas, with a long history of previous cultivation and soil erosion, improvement will be slow. It can be stated very definitely that on some areas, soil erosion and exposure has been so severe that any method of treatment is uneconomic, unless the market value of the crop is high. It is only owing to high prices of rubber in the past, due to certain factors which are not likely to recur, that some areas can be considered as economic.

Another distinct aspect of this problem is regeneration by means of rubber seedlings.

In view of our knowledge of budgrafting and seed selection this method of maintenance and regeneration of old rubber areas can also be ruled out as uneconomic.

Botanical Investigations

The re-orientation of research which has been under consideration as a result of the economic situation is indicated in the introduction to the report of the Botanical Division.

Botanical investigations, as a result of the demand of the industry until recently, have been concerned primarily with problems of vegetative reproduction and, to a lesser degree, with problems of

generative means of producing high yielding planting material. This orientation of work was due entirely to the situation in Malaya when the Institute was inaugurated, on account of the backwardness of Malaya in adopting methods initiated by our competitors. Had it not been for the present economic situation and the lack of funds for extension of new areas or for replanting of old areas with high yielding material, there is little doubt that no change of policy would have been demanded by the industry.

This fact must be appreciated in relation to the change or re-orientation in policy, particularly in respect of botanical investigations.

The nature of this re-orientation of work, which involves a study of tapping systems on mature rubber and the physiology of latex production which is closely related to systems of tapping is thoroughly discussed by the Head of the Botanical Division in the introduction to his report.

Appropriate arrangements have been made for conducting work of this nature without affecting to too great an extent the continuation of work to which we are committed in respect of problems concerned with vegetative reproduction of high yielding planting material.

IMPORTATION OF PLANTING MATERIAL

Both as a result of the reduction in extension of planting and the use of planting material raised locally, there has been a very considerable decrease in the importation of high yielding planting material—budwood and selected seed.

The importation figures for the year are as follows:—

Budwood	...	...	277 metres
Budded Stumps	...	...	320
Selected Seed	...	...	Nil

VEGETATIVE REPRODUCTION

Further investigations have been made in connection with the technique of budding, especially in relation to the treatment of large stocks, the treatment of the pruning cuts at the union of stock and scion, the planting of budded stumps and the transplanting of "stumped" buddings.

The results of these experiments are described briefly in the report of the Botanical Division.

One of the most important problems, the solution of which is not completed, has been the treatment of the pruning cut at the union of stock and scion.

Asphalt-Kerosene mixture which was recommended in the earlier stages of our knowledge and later a wax-sulphur mixture as a wound dressing are not entirely satisfactory. The latter mixture has been found to be generally unsuitable unless perfect shading of the pruned surface can be maintained.

It is probable, although this requires confirmation, that a steeply sloped cut on the stock, not treated with any mixture, may prove to be the most successful.

It is also probable that the higher temperature, which results from the applications of black wound dressings such as asphalt is responsible for damage and reduction in rate of callus growth.

GROWTH OF BUDGRAFTS

Further records of the growth of buddings of different clones have been made on the Experiment Station and on one estate on a replanted area in which clone trial plots were established. These will be continued until it is possible to compare yield records.

Useful information has also been collected and examined in respect of a comparison of the growth of buddings of a number of "proved" clones growing under different conditions on various estates. Observations on the results obtained are recorded.

DENSITY PLANTING

The first measurements of growth—height and girth—for buddings of clone A.V.R.O.S. 50 in a density planting experiment at the Institute Experiment Station are recorded.

These initial records indicate that growth is poorest in the most widely planted plot (30 feet x 30 feet.)

MIXED PLANTING

Further observations in relation to the mixed planting of clones and seedlings confirm our earlier recommendations as to the desirability of monoclonal or block planting of single clones.

INFLUENCE OF STOCK ON SCION

Measurements which have been made indicate a low degree of correlation between stock vigour and growth of scion on comparatively old and large stocks. These measurements however are of a preliminary nature and will be continued.

INFLUENCE OF SCION ON YIELD OF STOCK

The field experiments on this problem are not yet sufficiently advanced to enable observations to be made. The experiments designed for the investigation of the problem are however recorded.

STUDY OF LATEX SYSTEMS

Investigations of bark samples of various clones have been continued in connection with tapping experiments which have been initiated in order to confirm the observations which have already been made.

PHYSIOLOGICAL INVESTIGATIONS

The importance of work in relation to the physiology of the rubber tree, especially in respect of latex production, has already been indicated.

The bearing of this work on the economics of estate practice, especially in respect of tapping systems, is discussed by the Head of the Botanical Division in the section of his report dealing with this problem. A study of the statements made in this section of the report indicates the complexity of the problems and the proposed methods of attack. It is not possible to lay down what may be described as a direct method of attack of this problem, but only to indicate various methods of approach, all of which have a bearing on the problem. The chemical investigations which will be carried out on latex in relation to this problem will also be of importance in relation to problems connected with the quality of latex and rubber prepared from the latex, since the quality of these products is affected to a considerable extent by the non-caoutchouc constituents of the latex.

TAPPING EXPERIMENTS

In addition to the tapping experiments to be carried out on an area of mature rubber acquired for this purpose by the Institute, which are described in the report of the Botanical Division, other tapping experiments are in progress on certain estates especially on "double cut" systems. These have been carried out in collaboration with the Institute and records are received periodically for statistical analysis. A summary of the results are recorded to date with observations on the economics of the systems.

Results of tapping experiments on the Pilmoor Estate clones which have been in progress since 1928 under the supervision of the Botanical Division are recorded and show that these clones continue to give satisfactory increases in yield.

Bark renewal measurements in connection with these experiments can be described as satisfactory except in the case of one clone (Pilmoor A. 44).

Records of the influence of tapping heights, both on the yield of latex and on the dry rubber content of the latex from several

of these clones, are given. The results indicate a general decrease of yield as the tapping cut approaches the union of scion and stock while the yields from the high cuts tend to increase.

Latex from these experiments—from high and low tapping cuts—is being examined in the Chemical Division and may give valuable information in connection with the chemical and physical properties of the rubber.

SELECTION AND BREEDING

Work in connection with artificial pollination, seed selection and breeding has been curtailed, but will be continued on the material already available at the Experiment Station.

A summary of the position of this work is given in the report of the Botanical Division.

This also applies to the recording of yields of various Malayan estate mother trees from which new clones have been established at the Experiment Station.

The collection of budwood has however been completed and 202 clones have been planted in the field in Block 15 at the Experiment Station.

METHODS OF NURSERY SELECTION

Selection of nursery material by means of the Cramer knife has been carried out and plants thus selected have been established in permanent plots for comparison of yield records when the trees are sufficiently mature for test tapping.

TEST TAPPING METHODS

Several methods of test tapping in order to compare the results of such tapping at an early age with subsequent yield performance have been continued. This work is of importance in relation to the thinning out of poor yielders at the earliest possible age and for the selection of valuable clones.

ECOLOGICAL INVESTIGATIONS

In connection with the Forestry Method of cultivation, a large number of indigenous plants found on estates have been sent to the Institute for identification and for an opinion as to their suitability as ground covers. A collection of such material has been made for reference purposes.

A study of the stages of regeneration of natural flora on a badly-washed hill soil is also being made in a rubber area at the Department of Agriculture Experiment Station in Kuala Lumpur.

ADVISORY WORK

An analysis of the advisory work in the report of the Botanical Division shows the nature of the principal enquiries received. These enquiries indicate the problems which are of interest as far as most estates are concerned. As will be seen, the majority of these are concerned with budding and tapping systems.

The enquiries in connection with tapping systems on mature seedling trees support the necessity for a re-orientation of work in this direction, to which reference has previously been made.

Pests & Diseases and Pathological Investigations

LEAF DISEASES

There has been no serious epidemic of any disease during the year, apart from local outbreaks of mildew disease of the leaf caused by the fungus *Oidium Heveae*.

The outbreak however was not sufficiently intensive and widespread to merit treatment or further experimental work on sulphur-dusting during 1932.

The Institute however has two sulphur-dusting machines, so that, if an outbreak does occur, further work on the control of this disease can be undertaken.

A full report of sulphur-dusting experiments carried out in 1931 and also results of an investigation of meteorological factors affecting the virulence of the disease were published in the Institute Journal (Vol. 4 No. 2, November 1932).

MOULDY ROT

Mouldy Rot disease of the tapping panel has been prevalent in certain districts and its control on small holdings has been rendered more difficult owing to the economic situation.

The investigation of proprietary fungicides for the treatment of this disease has been continued and two additional fungicides examined during the year were proved to be very satisfactory.

An investigation of an outbreak of the disease has also enabled further conclusions to be drawn as to the effect of certain climatic conditions, the effect of undergrowth (secondary jungle or belukar) and the proximity of swampy land on the incidence of the disease.

ROOT DISEASES

Considerable attention has been paid to a study of the two principal root diseases of the rubber tree—*Fomes liposus* and *Ganoderma pseudoferreum*.

The main conclusions derived from these investigations are summarised in the report of the Head of the Pathological Division and indicate that both diseases can be controlled at the same time and at an early stage in the life of the rubber tree, if suitable measures are taken.

This will also result in considerable economy compared with the treatment necessary in dealing with mature areas which are attacked by *Ganoderma pseudoferreum* not discovered and treated when the trees were young.

INSECT PESTS

Further work has been carried out on the treatment of white ants with Paris Green which has proved successful on a number of estates.

The use of certain volatile insecticides absorbed by scrap rubber is also being tried.

The only other serious insect pest on rubber estates has been a Cockchafer grub (*Psilopholis Grandis*) which was first reported in 1931 on an estate in Perak and has since been reported on two estates in Selangor and Negri Sembilan.

No definite method of eradication has yet been discovered.

This grub appears to be very similar to a grub known to attack sugar cane roots, for which no suitable remedial treatment appears to have been discovered to date.

Chemical Investigations

LATEX CONSTITUENTS

Some progress has been made on the investigation and isolation of non-caoutchouc constituents of latex. These investigations are of primary importance in relation to the variability of raw rubber which is affected by the presence in variable proportions of such constituents.

This applies in particular to the possible effect of such constituents as vulcanisation accelerators, anti-oxidants, plasticizing agents and constituents which may affect the tensile properties of the manufactured rubber.

In this connection the lipin isolated from latex is of interest in relation to the milling properties of the rubber, while the protein constituents and their decomposition products may be of importance in relation to plasticity and vulcanizing properties. In addition both the organic and inorganic constituents may be of significance in relation to the physiology of latex production.

Apart from the above considerations, attention has been directed to the preparation of quebrachitol from latex serum with a view to possible commercial utilisation.

EXPORT OF LATEX

Considerable interest has been taken in the export of ordinary preserved field latex due to an increased demand for supplies received by a number of estates.

This necessitated a considerable amount of work on the determination of ammonia and dry rubber content of numerous samples of latex in addition to advice in other directions. Arrangements were made to instruct a number of planters in the technique of the necessary determinations so that they could be carried out on the estate.

The export of concentrated latex also continues to increase owing both to the development of new uses and to the use of concentrated latex as a substitute for raw rubber in certain existing manufacturing processes.

As far as Malaya is concerned two types of concentrated latex are exported; viz. (a) a concentrate known as Revertex, prepared by the evaporation of latex in the presence of a protective colloid or stabiliser, which contains about 69 per cent of "dry rubber" and about 75 per cent of total solids, (b) a concentrate prepared by the centrifugalisation of latex which contains about 59 per cent of "dry rubber". This concentrate is prepared at present only on the Dunlop Rubber Plantations and is marketed under the name of "Jatex".

Jatex differs from Revertex in that the latter contains all the constituents of the latex plus the stabiliser, whereas a proportion of the water soluble constituents of the latex in the former are removed in the "skim" which contains about 7 per cent of "dry rubber" and about 11 per cent of total solids.

In both cases ammonia is added to the concentrate for preservation.

Investigations have been carried out in the Chemical Division of the Institute on a third method of concentration, viz. creaming of latex in the presence of certain gums and vegetable mucilages and considerable interest has been shown in latex prepared in this way, since creamed latex had not hitherto appeared on the market.

All of these processes are however covered by patents in different countries so that no free market appears to exist for any type of concentrated latex.

Towards the end of the year there was a surplus of latex on the market and subsequent demand decreased. It must be realised that developments in the application of latex are slow, so that the

market demand at present is restricted and is rapidly over-supplied. Until some fairly large scale application of latex is adopted, e.g. for floorings or special roadways, an increased consumption will be slow and the demand for supplies may be erratic.

VARIABILITY IN PLANTATION RUBBER

The problem of variability in raw rubber still exists in relation to plasticity, rate of vulcanisation and other properties.

As a result of a questionnaire circulated by the London Advisory Committee to all leading rubber manufacturers in Great Britain, Europe, and the United States of America, somewhat conflicting views as to requirements were received. This is however due to the large number of different rubber articles which are manufactured, e.g. the cable manufacturer stresses the importance of low water absorption properties, since the problem of water absorption by cables affects the electrical conductivity of the insulating material. The desirability of preparing a type of raw rubber from which most or all of the non-caoutchouc constituents have been removed is of importance in relation to this problem since some of the serum constituents of latex are hygroscopic.

The principal problem of importance however is to supply a rubber which is uniform in its behaviour which necessitates bulking of latex to the greatest extent possible on the estate and uniform methods of preparation in relation to dilution of latex, coagulation and machining, drying and smoking.

SMOKED AND AIR-DRIED SHEET

Some interest is being taken in the preparation of air-dried sheet as a substitute for smoked sheet. In any case the separation of the drying and smoking processes is of importance to the producer since, by controlled methods of drying, considerable fuel economy can be effected.

Under present economic conditions however most estates are unable to instal steam or hot water circulation plants for the controlled drying of sheet rubber, by means of which economy in fuel can be effected.

A number of suitable sheeting batteries are now on the market in which the new lay-out in column or line ahead formation has been adopted. This lay-out, combined with a better synchronisation of speeds and wider rolls has resulted in a considerable speeding up of output so that a reduction in plant can be effected on large estates. On small estates the scrapping of old batteries and the installation of more modern types is not necessarily econo-

mic, provided the daily output can be manufactured in a reasonable period with the existing plant and lay-out. Economies however have been effected, even on small estates, by slight improvements and alterations which have resulted in the reduction of labour.

CREPE MANUFACTURE

Apart from the capital cost of heavy machinery, the cost of preparation of thin crepe rubber is higher than that of sheet rubber, due to the smaller out-put per machine and the higher power cost. At present however there is a sufficient premium on thin pale crepe to warrant its production on estates possessing crepeing batteries. It has not been possible hitherto to devote much attention to the problem of possible economies in the preparation of this grade. It is considered however that the use of lighter finishing machines is possible and it is of interest to record that one estate manager is now finishing about three quarters of his output on an ordinary light sheeting battery smooth roll machine, thus saving time and labour in the factory. The finished crepe appears to be just as thin and even in texture as that machined on the heavy smooth rolls of a crepeing battery, while the output is very satisfactory.

It is hoped that it may be possible to devote time to a more detailed study of this problem.

CLONE RUBBER

Investigations on clone rubber have been initiated and will be continued and extended as material becomes available, with the object of ascertaining whether the latex and rubber prepared from any particular clone possess special characteristics or properties. In view of our present knowledge however, it appears possible that the rubber manufacturer will be able to correct or modify any special characteristic of the rubber from a particular clone. Further, provided uniform methods of preparation are employed, the rubber from a particular clone should be very constant in quality, apart from variations caused by seasonal or climatic conditions.

CRUMB RUBBER

As a result of investigations carried out originally in the laboratories of the London Advisory Committee, raw rubber in the form of fine crumb or powder has been prepared. Another process for preparing crumb rubber has also been developed in Holland.

This rubber can be made either direct from latex or from thin pale crepe. Owing to its bulk and the fact that it will probably mass, if packed under pressure, it would appear that it may be more desirable to prepare crumb rubber at home from thin crepe rather than from latex on estates. This question however will depend on the demand and price, since transport and packing charges will be higher than for sheet or crepe. Investigations are being made at home on the possible applications of this type of rubber.

Samples of crumb rubber prepared at the Institute were exhibited at the Malayan Agri-Horticultural Exhibition held during the year.

MODIFIED RUBBERS

Investigations on modified types of rubber are in progress elsewhere which may result in new uses, eg. as a competitive product for articles at present made from the so-called synthetic resins or plastics; also rubber treated to render it suitable for the preparation of anti-corrosive paints. It appears desirable to consider the possibilities of treatment of raw rubber with substances other than sulphur, with the object of preparing a product which may find new applications in which the elastic, resilient and insulating properties of vulcanised rubber are not essential. Such investigations however must be considered as speculative and may require prolonged investigation before resulting in any increased use of the raw material.

RAW RUBBER AND RECLAIMED RUBBER

The possibility of preparing a modified type of raw rubber as a substitute for reclaimed rubber has also been considered and it is of interest to note that a patent has recently been applied for in this connection. There is however nothing novel in this idea.

It should be quite feasible, but the marketing of such a product would necessitate special arrangements between producers and consumers, since products of a definite type and known uniform composition would be required.

Although the present price of the best reclaims is high compared with that of raw rubber, there has been a marked reduction in consumption of reclaimed rubber, since the fall in market price of raw rubber and it is highly probable that the present price of reclaimed rubber is not remunerative.

RUBBER ROADWAYS

The investigation by the Institute of the possibility of preparing a rubber roadway product direct from latex, as distinct

from the various types of rubber capped blocks made from raw rubber has been continued. It is however our considered opinion that, owing to the large proportion of water in ordinary field latex, some form of concentrated latex, of which the dry rubber content is not much below 60 per cent, is essential for the satisfactory solution of this problem. Creamed latex, which may not be suitable for the manufacture of some articles, would appear to be as suitable as other types of concentrated latex for this purpose.

As is indicated in the report of the Rubber Roadways Chemist, the principal problems in relation to the satisfactory preparation of a mixture are, (a) the absorption of the water in the latex, which can be effected by the addition of a suitable aluminous cement, (b) the rapid setting of the product and the avoidance of cracking while the mixture is setting and consolidating.

The main problem which still remains to be studied is that of the ageing and wearing properties of the mixture.

A fairly low content of sulphur and vulcanisation accelerators, and the possible use of a suitable anti-oxidant are of importance in relation to ageing qualities. The possibility of a protective surface can also be considered in this connection. Only service tests over a number of years can however determine the ultimate possibilities of the product. It can however be definitely stated that the cost of a rubber roadway made in this way is much less than a roadway made from rubber capped blocks and compares favourably with other roadway surfaces. Apart also from the application of such a product for special roads on which the traffic is heavy, the utilisation of such a material for pavements would appear to offer a very promising outlet.

RUBBER OIL

As a result of a report made by the Rubber Growers' Association, which confirmed a report (unpublished) prepared by the writer, it was decided that no good purpose would be served by further investigations on rubber oil prepared by the dry or destructive distillation of raw rubber. It is not considered that such an oil or any suitable fraction of such an oil could compete with petrol or crude oil as a fuel for internal combustion engines or as a substitute solvent for turpentine.

These opinions have been confirmed more recently by a publication of investigations carried out in Holland. Samples of oil were however prepared in the Chemical Division of the Institute and have been submitted to the Rubber Growers' Association. From enquiries made by the writer while on leave, it is extremely

doubtful whether any interest will be taken in the samples submitted.

Experiment Station

The total area of the Experiment Station, as shown by the completed survey made by the Revenue Survey Department, is shown to be 2096 acres, of which 970.5 acres, including 695 planted acres have been opened. No new clearing was carried out during the year, but certain areas were re-allocated in connection with experimental work.

The possible exchange of the present reserve or a portion for another contiguous area having a different type of soil is still under consideration.

Apart from the building site and the elephant belt, the whole of the opened area has now been planted. Owing to the poor growth of many of the non-Hevea rubber plants on Block 22, it was decided to remove the best of these to the building site and to utilize this area for the planting of twin Hevea seedlings.

Since a number of the cover crops on Block 13A showed very poor growth and were obviously unsuitable, this area of 2½ acres was planted with rubber seedlings, using basket plants.

An area of 10 acres in the northern portion of Block 17 was also planted with stumps and seedlings derived from clone seed.

Apart from the above, the lay-out of the Station is the same as that published in the Annual Report 1931.

The Pathological Division is now in charge of disease work on all areas in consultation with the Heads of the Botanical and Soils Divisions on the Blocks under the supervision of these Divisions.

Systematic treatment for root diseases—*Fomes Lignosus* and *Ganoderma pseudoferreum* has been continued with satisfactory results.

Records of growth—girth and height—have been continued on various Blocks and published in the Institute Journal. Test tapping has also been commenced on a few trees and the results will be correlated with those obtained later when the trees are tapped regularly.

Further details of investigations at the Experiment Station are given in the Divisional reports and in the report of the Manager.

Conference and Lectures

The following lectures were delivered during the year:

<i>Subject</i>	<i>Venue</i>	<i>Lecturer</i>
Forestry Methods as applied to the Cultivation of Hevea	Annual Conference Incorporated Society of Planters	W. B. Haines
Industrial Uses of Latex	"	R. O. Bishop
The Physiology of Latex Production	"	C. E. T. Mann
Rubber Forestry	Incorporated Society of Planters (Tampin—Bahau Branch)	W. B. Haines
"	Incorporated Society of Planters (Nilai—Labu Branch)	W. B. Haines
Forest Undergrowth in Rubber Cultivation	Incorporated Society of Planters (Klang Branch)	"
Rubber Forestry	Malacca Planters' Association (Malacca)	"
"	Johore Planters' Association (Johore Bahru)	"
Factory Organisation	Incorporated Society of Planters (Tampin—Bahau Branch)	R. O. Bishop
Modern Factory Methods	Malacca Planters' Association (Malacca)	R. O. Bishop
Centralization, Latex Handling and Factory Procedure	Klang	"
Rubber Latex and its Industrial Applications	Rotary Club, Singapore	"
Tapping Systems	Incorporated Society of Planters (Tampin—Bahau Branch)	C. E. T. Mann
Recent Developments in Budding of Hevea	Incorporated Society of Planters (Klang Branch)	"

<i>Subject</i>	<i>Venue</i>	<i>Lecturer</i>
Recent developments in budding Hevea	Incorporated Society of Planters (K u a l a Selangor Branch)	C. E. T. Mann
” ”	Incorporated Society of Planters (Taiping Branch)	“
The Work of the Rubber Research Institute especially in relation to the preparation of Raw Rubber	Cable Manufacturers' Conference, London	B. J. Eaton
The Preparation of Raw Rubber in relation to Manufacturers' Requirements	Institution of the Rubber Industry (Midland Section, Birmingham)	”
	” (London Section, London)	”

Exhibitions

The Institute took part, as in previous years, in staging instructive exhibits at the Annual Exhibition of the Malayan Agri-Horticultural Association held in Kuala Lumpur from 30th July to 1st August.

Publications

The following publications were issued during the year:—
Annual Report 1931.

Journal—one number of Vol. 3 (No. 3) and two numbers of Vol. 4 (Nos. 1 and 2).

Manual No. 3. Plantation Sheet Rubber Manufacture.

Manual No. 4. Latex Preservation and Shipment.

Information Cards on the Preparation of and Defects in Raw Rubber—Nos. 22C—25C (No. 25C is an Index to the Series).

The Guide to the Experiment Station, containing a plan of the experimental plots, soils map, and notes on the history of all the plots was revised during the year and issued to Members of the Board and the London Advisory Committee.

Library

A report by the Librarian is included for the first time. The indexing of all articles of interest in scientific and technical journals

received by the Institute is carried out by the Librarian, who is also responsible for the distribution of all Institute publications.

Visitors

A large number of visitors, especially planters, have visited both the Institute Laboratories and the Experiment Station during the year.

Members of the Kajang branch of the Incorporated Society of Planters also paid combined visits to the Institute and Experiment Station.

Special visitors to the Institute included the following:—

H. E. the Governor, S.S., and High Commissioner, F.M.S. (Sir Cecil Clementi, G.C.M.G.), the Hon'ble the Chief Secretary, F.M.S. (A. Caldecott Esq., C.M.G., C.B.E.), G. A. Murray Esq., Director of Agriculture, Rabaul (New Guinea), Dr. P. J. P. Cramer (Holland), J. Grantham Esq., Adviser, H.A.P.M. (England), Dr. Whitfield (Rubber Manufacturers' Association, U.S.A.), F. A. Williams Esq. (American Trade Commissioner, Singapore), R. Boulter Esq. C.M.G. (H. M. Trade Commissioner, Singapore), G. Sackett Esq., Chemist, Goodyear Plantations, Sumatra (Goodyear Tyre and Rubber Co., U.S.A.).

General

I wish to express to numerous managers of estates and estate factory superintendents our thanks and appreciation for their valuable co-operation in many branches of the work of the Institute during the year.

The analyses of correspondence and advisory work of the various Divisions are attached as an Appendix to the Director's report.

Annual Reports by the Chairman of the London Advisory Committee for Rubber Research (Ceylon and Malaya) and the Superintendent of Laboratories, operating under this Committee on behalf of both Malaya and Ceylon, for the first year of existence of the joint Committee, are included as appendices to the Reports of the Institute's activities.

B. J. EATON

Director

APPENDIX
SOILS DIVISION
Analysis of Correspondence.

Subject				Letters received	Letters despatched
Cultivation—General Enquiries	...	...	...	9	11
—Forestry Methods	...	...	...	60	73
Cover Crops and Natural Covers	...	...	...	101	124
Manuring	...	...	...	92	74
Soil Conservation	...	...	...	6	6
Replanting	...	...	...	7	8
Fertilizers	...	...	...	7	9
Soil Samples	...	...	...	48	55
Miscellaneous	...	...	...	81	122
Total				411	482

BOTANICAL DIVISION
Analysis of Correspondence.

Subjects.		Letters received	Letters sent out
I. Budding.	General. Advice on choice of clones. Clone Records	332	405
"	Training of Conductors & Pupils from Estates, etc.	2	2
"	Field Experiments (Estate Trials)	2	3
"	Growth of Budded Trees	131	35
"	Purchases & Exchanges of Budwood	15	21
"	Special material	1	2
		483	468

Subjects.		Letters received	Letters sent out
II. Tapping.	Estate Enquiries. General	144	154
"	Estate Experiments		
	General	48	53
"	Estate Enquiries (Tapping of Budded Trees) ...	10	13
"	Estate Experiments. (Tapping of Budded Trees)	96	106
"	Test-tapping of seedlings.	8	9
"	Tapping Systems (Sunday Tapping)	5	5
		311	340
III. Selection.	Individual Mother Trees; selection on Estates ...	144	163
"	Estate Yields.	2	2
"	Seed Selection	18	27
"	Latex Vessel & Bark Examinations	2	2
"	Isolation Gardens. ...	13	17
"	Seeds for Experimental Purposes	9	10
		188	221
IV. General Planting Enquiries	...		
"	Information on planting operations.	14	16
"	Cover plants.	77	95
	Catch Crops.	2	3
"	Thinning	3	3
		96	117
V. Apparatus		3	3
VI. Miscellaneous.		24	39
	Grand Total ...	1105	1188

PATHOLOGICAL DIVISION

Analysis of Correspondence.

1. Letters received,	464
2. Letters and Reports despatched,	654
3. Number of visits paid to estates,	101
4. Number of samples examined,	114

CHEMICAL DIVISION

Analysis of Correspondence.

Defective Smoked Sheet	...	...	...	178
Wet Sheet	...	...	...	19
Air-dried Sheet	...	...	...	43
Vulcanised Rubber	...	...	...	241
Clone Rubber	...	...	...	277
Crepe Rubber	...	...	...	148
Water	...	...	...	30
Hydrometers	...	...	...	133
Preserved Latex	...	...	...	1,985
Concentrated Latex	...	...	...	9
Dry Rubber Content of Latex	...	...	...	8
Rubber Roadways	...	...	...	2
Anti-coagulants	...	...	...	18
Anti-oxidants	...	...	...	12
Shirlan (Fungicide)	...	...	...	4
Revertex	...	...	...	4
Creamed Latex	...	...	...	19
Gum or Gum Tragacanth	...	...	...	35
Rubber Oil	...	...	...	3
Rubber Benzine	...	...	...	1
Rubber Tar	...	...	...	1
Formic Acid	...	...	...	21
Sulphuric Acid	...	...	...	3
Ammonia	...	...	...	28
Other Chemicals	...	...	...	45
Rubber Paint	...	...	...	6
Miscellaneous	...	...	...	16
Coagulating Tanks and Pans	...	...	...	3
Accelerators	...	...	...	35
Latex Serum	...	...	...	5
Serum Constituents	...	...	...	2
Packing	...	...	...	3
Acid Proof Cement	...	...	...	5
Centrifuged Latex	...	...	...	13
Crumb Rubber	...	...	...	1
Rubber cured with machinery	...	...	...	1
Sludge from Ammoniated Latex	...	...	...	1
Utermark Skim Sheet	...	...	...	2
Total				3,360

CHEMICAL DIVISION

Analysis of Correspondence

Subjects			Letters Received	Percent- age of Total	Letters despatched
Anti-oxidants of Latex	...	...	13	0.57	15
Anti-coagulants of Latex	...	...	27	1.18	37
Machinery for Rubber Manufacture	...	...	134	5.86	179
Vulcanising Machinery and Apparatus	...	...	8	0.35	11
Vulcanisation of Rubber	...	...	95	4.16	96
Rubber Seed Oil	...	...	3	0.13	8
Crepe Rubber	...	...	47	2.06	55
Crepe Rubber—Lower Grades	...	...	7	0.31	7
Coagulants	...	...	99	4.33	110
Rubber Preparation (General)	...	...	88	3.85	98
Latex	...	...	51	2.23	68
Latex Preservation	...	...	744	32.55	812
Latex Concentration	...	...	81	3.54	85
Latex—Instruments for determining					
D.R.C.	...	...	155	6.78	214
Coagulating Tanks and Pans	...	...	48	2.10	67
Sole Crepe	...	...	23	1.01	27
Smoked Sheet	...	...	129	5.64	143
Smoke Houses	...	...	115	5.03	145
Air-dried Sheet	...	...	65	2.84	87
Water Samples	...	...	14	0.61	20
Accelerators for Vulcanisation	...	...	35	1.53	42
Rubber Fillers	...	...	3	0.13	3
Rubber Softening Agents	...	...	—	—	1
Patents	...	...	20	0.87	46
Miscellaneous	...	...	92	4.02	134
Orders for Chemicals	...	...	2	0.09	2
Rubber Paving for Road Surfacing	...	...	73	3.19	125
Quebrachitol	...	...	51	2.23	66
New Uses of Rubber	...	...	24	1.05	36
Rubber Substitutes	...	...	—	—	1
Rubber Paints	...	...	18	0.79	29
Raw Rubber Powder	...	...	17	0.75	17
Wood Tar	...	...	2	0.09	3
Rubber Benzine	...	...	3	0.13	3
Total			2,286	100.00	2,792

ANNUAL REPORT

SOILS DIVISION

STAFF

Dr. C. F. Flint proceeded on leave at the beginning of February. Later in the year, as a retrenchment measure, four appointments in the Division were abolished. These included: Dr. Flint, one graduate analyst, one laboratory assistant and one field conductor. Omitting the Head of Division and the laboratory attendants this amounted to a reduction to half strength.

ADVISORY WORK

The amount of advisory work increased a little compared with the previous year, but on the whole it may be said that a fairly stable position has been reached. The analysis of correspondence which is included in the Appendix attached to the report of the Director shows a great increase in interest in cultivation questions, the number of queries being four times the figure for the previous year. This reflects the needs of the industry and such revival of interest is a matter for congratulation.

The number of samples submitted for analysis decreased slightly. On the other hand the amount of routine analysis accomplished has been steadily increasing, as shown in the following table:—

	1930	1931	1932
Number of samples sent in, ...	273	369	338
Number of analytical determinations made,	1361	2742	3473

This increase in capacity has been mainly applied to systematic investigations of typical soil profiles. An analysis of the different determinations made is given in the Appendix hereto.

In several cases the Division has also made measurements on bark samples submitted. In connection with records of manuring or cultivation experiments the measurement of bark thickness is often desired. The taking of measurements in the field offers certain disadvantages, and it has been found to be more accurate and convenient to make measurements on the bark samples in the laboratory with a thickness gauge. These samples can be simply taken with a cork-borer and sent in suitably packed in damp paper.

The number of estates visited in the course of advisory work was 74.

Enquiries have been received with regard to utilising waste products such as scrap rubber or serum as soil fertilisers. Reports have apparently been circulated regarding the improvements noticed from the burying of scrap. This might be partly due to the effect

of the cultivation and the physical properties of the shreds of rubber in keeping the soil porous. The actual manurial value of the scrap must be very small. Even if it be assumed that the tree scrap contains a higher proportion of serum constituents than the coagulum of pure latex, it would have only about one-twentieth the value of an ordinary compound chemical fertiliser. Thus the scrap could not be valued at more than about $\frac{1}{4}$ cent per lb. for such a purpose.

A sample of factory waste water containing latex serum was submitted, from which the following calculations were made. The acidity was about the same as that of our average soils ($pH = 4.80$). Twenty thousand gallons per acre of this factory waste (equivalent to about one inch of rain) would be equivalent to a dressing of 1 ton of total solids (mostly organic compounds) and would contain 82 lbs. of nitrogen, 92 lbs. of potash, but only 3 lbs. of phosphates. An application of this sort would temporarily upset the soil equilibrium, but it could be done occasionally with benefit. The feasibility of such a plan of irrigation is very limited, for, although the effluent is produced daily, its application would not be possible in wet weather, and, since factories are generally low lying, areas to which the effluent could be transported by simple flow would usually be very limited. No other method of transport could possibly be considered for such a bulk and for such a small problematical benefit.

One soil sample of an unusually acid character was submitted for examination. It came from an area on the coastal flats which had been under sugar cultivation in the early days. The pH value of the surface soil was 3.5. An electrometric titration was carried out on this sample to investigate the buffer relationship. The results indicated that to neutralise the top 9 inches of soil some thirty tons of lime per acre would be required. The rubber on this area responded well to fertilisers, so that it may be concluded that the acidity is still within the range of tolerance of the tree. The effect of such a pH on the micro-biological activities in this soil would offer an interesting study.

FORESTRY METHODS

A great deal of discussion has taken place during the year over the new view-point in soil management indicated under the term "forestry method." There can be no doubt that ultimately much improved practices will be developed, but progress is hampered by unbalanced views. This opportunity will therefore be taken to reiterate some of the main points which stand out in the year's discussions.

For our purpose it is necessary to distinguish clearly between the application of forestry ideas to soil management and to crop

management. The former is highly desirable but the latter bristles with uncertainties and difficulties. To advocate natural and continuous regeneration of the stand of trees as in timber production involves such a revolution that a very clear demonstration of success, which would allow of adequate criticism of costs, of labour discipline, and of disease control, would be necessary before its adoption could be seriously considered. Such a demonstration involves a long period of time. The need for a revolution in soil management, on the other hand, is plainly apparent to anyone with an elementary appreciation of the past effects of soil exhaustion, exposure and erosion. That the realisation has not been made earlier may be largely attributed to the failure to use any criterion except yield as a test of the fitness of a field of rubber. This introduces a big time-lag between the onset of a weakening in vegetative vigour and its final realisation in falling yields. By that time bark conditions may have so deteriorated that an equivalent time-lag will ensue with any measures taken for recovery. The measurement of average girth of the trees is both simple and accurate, and it may be suggested that, if such records were kept regularly, a reliable and unambiguous criterion would exist to indicate the changes in vegetative health of a field. The fact is that much rubber standing to-day has made no perceptible increase in girth over many years, and, if this had been clearly brought home to directors at an earlier stage, corrective measures might have been adopted in time.

Much of the first interest in the claims for forest methods seems to have arisen from the expectation that immediate costs could be reduced thereby. This may be so inasmuch as the first step is mere cessation of weeding, but there ensues a period of control which involves expenditure, and this may be greater than that required when transition is complete and stability is reached. A statement from a discussion of manuring experiments which was published by this Division (R.R.I. Journal, Vol. 3, No. 2, 1931) has been much quoted and rather misunderstood on this question of costs. The passage in question was a summing up of the situation, in which the need for nitrogen had been stressed and also its expensiveness as an artificial dressing. The alternative method of stimulating the natural production of nitrogen in the soil was indicated and a prophecy made of coming changes in cultivation methods along this line. If vegetative vigour of a stand of rubber is to be maintained under a policy of clean weeding then a necessary concomitant in many situations is nitrogen manuring, and the quotation in question was meant to offset this against the possibility that this need might be avoided if the nitrogen-producing activities of the soil were preserved by forestry methods. Thus, *for the same results*, the cost comparison is between, (1) the control of a natural cover and (2)

clean weeding, plus mechanical soil conservation, plus a manuring programme. The latter alternative might still prove the best for managing a high yielding area under intensive methods, for it certainly allows of the tightest discipline and supervision, but there are strong grounds for advocating the other alternative in present stands of rubber. Weed growth suffers under soil deterioration just as the growth of the rubber does, so that continued clean weeding sometimes ultimates in such poor weed growth and such low weeding costs that no method of control of a natural cover is likely to make a favourable comparison on the single basis of monthly outlay. The ultimate welfare of the rubber (i.e. stable yield capacity) and not immediate outlay must be the point of view in approaching the subject.

In some quarters an immediate increase in returns seems to have been expected from the application of forestry methods. This mistake should not have been made after the discussion of the slow results from manuring, for the natural method of soil amelioration cannot be quicker than the artificial one, though it has the great advantages of stability and durability.

A great deal has been written about the effect of "noxious growths" in rubber, which has led to a belief that weeds should be divided into rigid classes as good or bad. It cannot be too strongly emphasised that planters will be better employed in studying the general principles laid down in relation to their own local conditions, than in studying fine botanical distinctions. There is more danger of letting a cover get out of hand (i.e. unduly costly for its proper control) than of injuring the rubber by ingress of deleterious growths. Indeed, deleterious effects are mainly associated with simple lack of control. As far as the writer's observation goes nearly all cases of supposed injury can be explained on the broad basis of competition between rubber and cover for available soil nutrients and for light. The "noxious growths" are simply those that have an ability to utilise a poor soil so well that, in really bad cases, the weakened rubber cannot exert its natural predominance by shade and so loses in the fight. In a better situation where competition is not so intense the same cover may do no harm, for the rubber responds by an improved canopy and so keeps control. Certain grasses like lallang and cattlegrass may be suspected of specific toxic effects, but if other cases exist, they are not yet proved. We know of no valid test except the response of the tree itself, and this is sluggish by the very nature of things where deterioration has been prolonged. The experiments necessary to unravel these points were under discussion during the year, and are being taken in hand at the time of writing. Every field must be considered on its merits, a start being made with the available flora, keeping strictly in view the

general principles and, by gradual selection, working from the less desirable to the more desirable.

Since the cover of rubber seedlings used in the early experiments is viewed by most people simply as a cover, and not as a potential source of a new stand of trees, interest has been shown in the selection of other shrubby plants with better characteristics. There are a number of plants which have become classified loosely under the "*Rubiaceae*" which would seem to serve the purpose well. In particular the possibility of collecting seed for planting on very denuded areas, where nothing desirable appears naturally, is being studied. One planter has experimented in this way with *Fagraea racemosa*. The first requirement is that the plant selected should be able to establish itself readily on poor soil. *Fagraea* has this property besides being shady and non-woody. Methods of control have yet to be worked out. One way would be to maintain only young or slashed plants at waist high (retaining a few mature seed-bearers). The planter in question intends to try another method, attaining an increased overhead shade by means of mature plants so pruned that there is no interference with the view of an inspector. The shade would be sufficient to maintain a bare forest floor. Experiment will settle questions of costs and how diseases (especially of the tapping panel) may be affected.

During the year a well-known visiting agent, who has had good opportunity of close observation, has expressed himself in a lecture on this question of forestry as a means of crop management. His main conclusions were (1) that self-sown seedlings under forest rejuvenation make very slow growth and produce very poor trees in comparison with the results of more conventional methods, (2) that the humid conditions and poor visibility produced by the close growth make mouldy-rot a very serious menace and its control very difficult. These conclusions seem quite incontrovertible. The same lecturer, however, fully admits the soil benefits to be derived, and this fact cannot be neglected by those who take the long view. It indicates the line of approach for those who wish to regenerate their soil as a preliminary to replanting (which would be carried out by conventional methods), and supports the endeavour to work out a compromise by means of which the advantages of soil improvement can be gained without the obvious disadvantages outlined above.

MANURING

Results continue to come in which indicate the improvements which can be effected with fertilisers, but the economic position has continued to keep the subject in the background from the practical point of view.

In one interesting case the result of several years' manuring became suddenly very marked when a new tapping panel was opened, showing the connection between yield and the conditions of nutrition under which bark renewal has taken place. In another case 15 per cent. increase was recorded from plots of very poor rubber under heavy bracken, although no vegetative improvement was noted.

A manuring experiment of six years' standing, where tapping had been closed down owing to the slump, continued to send in girth measurements. The control plots had made no increase in girth during the whole of the six years, but all the manured plots had made progress.

Another experiment clearly demonstrates the advantages of manuring soils which have been exhausted by previous cropping, to secure a proper growth with young trees. When a proper start has once been given the future development is much easier to maintain. The area in question is in S. Johore and the experiment has verified the first diagnosis that phosphates would prove the limiting deficiency. At the present time, which is three years after the last manuring, the treated plots are showing much more rapid development than the controls. In particular the superphosphate plot made more than double the relative growth shown by the controls. This should not be taken as a proof of the superiority of superphosphate over other forms of phosphate under Malayan conditions; the less soluble forms such as bone-meal or very fine rock phosphate are often to be preferred. The result may probably be attributed to a deficiency of calcium in this case, which would be supplied by the superphosphate but not by the other fertilisers chosen for this experiment.

Were it not for the cost, manuring would be the most scientific way of dealing with some of the problems of natural covers. Liming, for instance, is a very useful adjunct in suppressing stag-moss. Ammonium sulphate seems generally to be taken up better by the rubber tree than by natural covers—indeed a weed cover is often immediately restrained by its application. Such treatment is therefore ideal in recovering those poor areas where covers like bracken are winning in the competitive fight. An application of sulphate of ammonia will retard the bracken and improve the leaf-age and shade of the rubber. Thus the proper predominance of the rubber is again restored and careful management should be able to maintain it without further manuring. The low value of such stands of rubber, however, makes the procedure doubly uneconomic.

LABORATORY WORK

As previously stated a part of our work in routine analysis has been devoted this year to the examination of typical soil profiles. A large number are now ready for publication and discussion.

An improvement in the routine made this year was the institution of base exchange determinations as one of the ordinary estimations for our soil samples. Work was also continued in the critical examination of other methods of analysis.

The work on manganese in Malayan soils and the amount taken up by Hevea, already noted in last year's Report, was continued during this year. Samples from a plot which had received manganese in a fertiliser treatment indicated that this element had not been retained in the soil.

Several minor investigations were conducted upon problems arising under the discussion of forestry methods. The claim had been made that some plants (e.g. Stagmoss) make the soil more acid. Tests carried out on this question gave negative results, indicating that, if any such effect exists, present laboratory methods are not sensitive enough for its clear demonstration. In extension of this work a thorough pH survey was begun on the area of mature rubber in the Lake Gardens, Kuala Lumpur (taken over by the Institute in the middle of the year). This will form a basis for examining the later changes under the natural covers, which are being developed. Analyses were made of various natural cover-plants with a view to assessing their relative value in humus formation. Bulk quantities of decomposed material from the commoner varieties were also prepared for further study of the types of decomposition. In regard to the use of rubber seedlings as a cover an experiment was started to determine what may be the optimum stage of growth to conduct slashing or pruning operations.

A series of measurements were made during the year to investigate the soil moisture relationships under natural covers. One plot was chosen under grass and another under bracken (*Gleichenia*), both of them being in mature rubber, and the moisture determined at several depths at short intervals of time. The water percolation was much better under bracken. The movement of water after a heavy shower could be traced during several days, and the tendency under bracken was for a region of high moisture to be retained at about 15 inches depth. Under grass the moisture maximum was always near the surface, and it may be assumed that the loss by run-off was greater on this plot. The results could also be interpreted to mean that the soil aeration under grass would be less than under bracken.

In connection with the planting of natural covers mentioned elsewhere a question arose as to the germination of the seed of *Fagraea racemosa*. Field observations seemed to indicate that the seed lies dormant in the soil a long time. Experiments were therefore started on methods to induce more rapid germination, and they have already given some useful indications.

METEOROLOGICAL

Readings have continued as heretofore, including soil temperature and special measurements of rainfall intensity.

A comparison of monthly rainfall at the Institute and at the Experiment Station is given in the accompanying table. As in previous years, the Experiment Station has slightly the higher rainfall.

Summary of Rainfall, 1932

	Experiment Station	Laboratory
January	... 4.92	4.17
February	... 8.98	5.43
March	... 10.51	11.76
April	... 6.19	8.50
May	... 8.67	6.37
June	... 2.40	1.61
July	... 2.77	1.38
August	... 12.73	11.82
September	... 8.31	4.65
October	... 17.29	9.29
November	... 11.76	14.72
December	... 12.74	11.79
Total	... 107.27	91.49
Previous year's total	... 97.15	93.58

EXPERIMENT STATION

The cultivation experiment in Block 19 to test the effect of grass and of digging-in periodically was begun this year. The measurements have shown no significant result as yet.

A small experiment was laid down to test the effect of a collar of Pabco paper round the young trees. Soil temperature measurements have been recorded in connection with this.

The block of rubber grown in belukar (Block 11) has shown a severe setback in rate of development during the year. The average girth increase (at 1 ft.) for the year was 3.7 inches compared with 6.0 ins. as the standard for other clean weeded blocks of the same age. This was not altogether expected, nor is it entirely in keeping with results elsewhere. Control of the belukar by slashing did little to reduce the retarding effect. Test pits were dug to examine the water table over the area, but no abnormality was discovered. Further development will be watched with great interest.

A visit was made to the Forest Reserve in connection with the Institute's reserve area, and a number of soil samples examined.

Soil samples were taken from Block 6 manuring experiment for analysis. The results showed that phosphate was the only element that had accumulated as a result of several applications of a complete inorganic fertiliser.

Measurements on nearly all blocks are now taken at six-monthly intervals, providing us with critical data on many points which have long been the subject of uncertain debate.

LECTURES

Six lectures were delivered by the Head of Division during the year; all of them dealt with questions of soil management from the forester's standpoint. The most important occasion was the I.S.P. Annual Conference at Port Dickson in September. The other lectures were delivered at Tampin, Nilai, Malacca, Klang and Kluang.

EXHIBITION

Mr. Akhurst gave a good deal of time in arranging the general details for the Institute's exhibit at the Malayan Agri-Horticultural Association's Show in August.

PUBLICATIONS

- (1) Memorandum on Forestry Methods (in collaboration with other Divisions) Journal. Vol. 4 No. 1.
- (2) "Forestry Methods in Rubber Cultivation," W. B. Haines The Planter, October 1932.
- (3) "Effects of Covers and Cultivation Methods in Young Rubber III," W. B. Haines, Journal. Vol. 4, No. 2.
- (4) "The Carbon and Nitrogen Contents of some Natural Covers" C. G. Akhurst, Journal. Vol. 4 No. 2.

A very complete resumé of the subject of base exchange was prepared by Mr. Pillai in connection with his work with Dr. Flint on this subject. It gives a critical and up-to-date discussion of the position with full references and certain of our own results, but arrangements have not yet been completed for its publication.

W. B. HAINES

Head, Soils Division.

APPENDIX

ANALYSIS OF ROUTINE CHEMICAL WORK

SAMPLE EXAMINED FOR :	NO. OF DETERMINATIONS	
Colours of wet and dry soils	...	156
Loss on evaporation	...	237
Loss on ignition	...	114
Mechanical analysis (sand, silt & clay)	...	103
Sticky point	...	45
Index of texture	...	33
Sand fraction	...	17
Ether soluble matter	...	1
Density	...	1
Exchangeable bases	...	216
Exchangeable hydrogen	...	144
Lime requirement	...	12
Electrometric pH	...	464
Colorimetric pH	...	173
Carbonate	...	2
Carbon (org.)	...	543
Nitrogen (org., NO ₃ or NH ₃)	...	528
Phosphate (acid or water extract)	...	276
Potassium (acid or water extract or exchangeable)	...	282
Sodium (acid or water extract or exchangeable)	...	58
Calcium (acid or water extract or exchangeable)	...	14
Magnesium (acid or water extract or exchangeable)	...	12
Fe ₂ O ₃	...	18
Al ₂ O ₃	...	12
SiO ₂	...	12
Total Number of determinations ...		3,473

ANNUAL REPORT

BOTANICAL DIVISION

In the course of the year under review the organisation of the work of the Botanical Division has undergone important changes. The exigencies of the economic situation in the rubber industry in general and the plantation industry in particular have made it necessary to reconsider the whole question of botanical research on plantation problems.

The programme of botanical work drawn up towards the end of 1931 was reviewed again in February 1932 and, in view of the opinion held at that time that the year 1932 would see a considerable reduction in revenue, necessitating a corresponding reduction in expenditure, the relative importance of each branch of research was carefully considered and discussed.

The main conclusions reached in the course of this discussion were:—

- (1) The existing situation demanded that closer attention should be given to fundamental work on the physiology of latex production
- (2) So far, owing to the wide interest taken in the development of methods for obtaining new areas of high productivity, there had been a certain lack of balance in botanical research and it was considered that the problems of older mature rubber areas had not received an adequate measure of attention.

Accordingly, proposals for investigations which have as their ultimate object the improvement of planting material with a view to obtaining increased production from new plantings were first examined. This object may be attained by a careful study of variation in *Hevea* followed by selection and propagation by vegetative methods (budding) or generative methods (breeding and further selection).

Although the greatest ultimate improvement will undoubtedly be effected by means of careful genetical work, probably supplemented by further application of vegetative methods, propagation by vegetative means has quickly given a considerable measure of success. By far the greater proportion of the new rubber areas developed since 1925 have been planted or re-planted, with budded trees of the best clones developed by vegetative methods. The Rubber Research Institute is under a definite obligation to those who have followed its advice in the use of this new planting material and, in order that further reliable advice and assistance

may be given regarding the new problems which the development of these recent plantings will inevitably present, it was considered essential that research on the subject of vegetative propagation should be continued.

Research on the improvement of Hevea by generative means has been steadily pursued during the past five years but, owing to the nature of genetical work on permanent crops such as Hevea, the results of this work have not as yet found application in practice. The reasons for this are quite clear. At least ten years must elapse from the time of establishing pedigree families of Hevea seedlings before it is possible, by means of long period tapping tests, to determine their value. Having reached this stage satisfactorily, the problem of how to repeat desirable crosses on a sufficiently large scale to obtain the quantities of seed required for large scale commercial planting remains to be solved. Even if we are able to short circuit the process by establishing new clones as early as possible from the best individuals of any particular family, a minimum period of ten years would be required for the establishment of a new clone equal in value to the best proved clones at present in commercial use.

After careful consideration it was decided to abandon for the present the proposals for further work on breeding of Hevea and to restrict research on this subject to the maintenance and study of the material already prepared and established on the Experiment Station at Sungei Buloh. The grounds on which this decision was taken were the following. Genetical work aims at developing high grade planting material for the future plantings. The uncertainty which clouds the future development of the rubber plantation industry makes such work of doubtful commercial value. With every prospect of reduction in the funds available for research the utilisation of these for work which can only benefit new plantings cannot be justified at a time when pressing problems concerning economic production from existing plantations await solution. Furthermore, recent researches have indicated that it is possible to obtain very superior seedling trees from the seeds of budded trees of proved clones already so widely established and it may thus prove possible to establish commercial plantings of high grade seedling material in a much less laborious manner than by careful genetical studies.

The proposals for research on the physiology of latex production were next examined and considerable expansion of work on this important subject was deemed to be desirable. So far, the work of the Botanical Division has been seriously handicapped in this direction owing to the fact that the Rubber Research Institute does not possess an area of mature rubber suitable for the conduct

of large scale field experiments. Such experiments must play a most important part in work on the physiology of latex production, particularly in relation to tapping practice and the study of the physical and chemical properties of latex. Though valuable work has been done in the past by co-operation with estates, under existing conditions facilities for such work had become increasingly difficult and it was therefore decided to make provision for future work by obtaining control, either by lease or purchase, of suitable areas planted with mature rubber. During the year the necessary arrangements were made and a full programme of work on the physiology of latex production in relation to tapping and the study of latex properties has been approved and will be put into operation in 1933. Certain aspects of the physiology of latex production can be investigated satisfactorily by means of tapping experiments on budded trees and in this direction important advances have been made during the year in continuation of the work on Pilmoor Estate and Glenshiel Estate. The physiology of latex production is a complex subject and its adequate study calls for close collaboration between the botanist, the chemist and the physicist. The need for more co-operative work was emphasised during the discussions by the Research Committee of the Board and wherever possible joint work has been undertaken during the year.

STAFF

The writer returned from home leave on February 7th, 1933, and assumed duty as Head of the Division. Mr. L. E. Morris, Geneticist, left for home leave on March 4th, 1933. Mr. C. C. T. Sharp, Botanist, continued his work on certain problems in vegetative propagation and initiated new work on the physiology of latex production in relation to tapping systems on mature seedling trees. Mr. K. N. Kaimal, Assistant Botanist, continued joint work with the Head of the Division on tapping of budded trees. A laboratory investigation on the study of the latex vessel systems of budded trees and a considerable amount of systematic work in connection with the recent development of forestry methods of cultivation were also undertaken by the same officer.

On the departure of Mr. L. E. Morris on leave Mr. F. Billington, Field Officer, continued certain investigations and completed the necessary field experimental work in connection with these at Sungei Buloh prior to his departure in August 1932. Mr. G. Davidson, Field Officer, in collaboration with this Division, initiated two tapping experiments on Caledonia Estate. Since Mr. Davidson's departure in August, these experiments have been carried on by the estate staff.

The recommendations of the Retrenchment Committee accepted by the Board came into operation on August 1st, 1932, since which date the Senior Staff of the Division has consisted of two senior officers, Mr. C. E. T. Mann and Mr. C. C. T. Sharp, and one graduate assistant, Mr. K. N. Kaimal.

In the present report the survey of the year's work is presented in sections, each section covering one main line of investigation. For convenience of reference, work on the Experiment Station is summarised separately and advisory work is also dealt with in a special section. In the brief reports of investigations in progress the name of the officer responsible for the work appears in italics at the end of the report.

1. Vegetative Propagation

(1) TECHNICAL OF BUDDING OPERATIONS

Experiments were carried out with the Garrot method of budding. In this method the tongue of the stock bark is opened from the base of the tree upwards and the prepared bud patch inserted below. The tongue and patch are covered by a small strip of bamboo which is held firmly in position by a strand of wire twisted firmly around the base of the tree and over the centre of the bamboo shield. Results on large stocks, 3 to 4 years of age, were very good, especially under fairly dry conditions. On small stocks the results were less promising and definitely inferior to those obtained by the old method with the usual waxed bandage.

The new method can be recommended for budding on large stocks and the cost per budding is about one quarter of the cost of the waxed bandage method.

Very satisfactory results were obtained in nursery budding on normal sized stocks using vulcanised rubber tape in place of waxed bandages. Rubber tapes 12 to 18 inches long, cut from discharged inner tubes, have been used successfully on estates. The budding results compare favourably with those obtained by the old method and, as the rubber tapes can be used several times, the cost of the budding operation can be considerably reduced.

C. E. T. Mann

In continuation of the experiments by Mr. Sharp on the influence of "time of opening" on the ultimate success of budding on large stocks, further tests were

carried out during the current year. Budding in the field was carried out in May using clones A.V.R.O.S. 50, 71 and 256, Tjirandji 16, Bodjong Datar 10 and Ct. 88 (Java). Half of the buddings made were opened after 18 days; the remainder after 23 days. The former group gave an initial success of 84 per cent and finally 54 per cent of growing buddings, compared with an initial 80 per cent and a final 64 per cent for the group opened after 23 days. The results agree very closely with those reported by Mr. Sharp (R. R. I. Journal, Vol. 4, p. 39, 1932).

F. Billington

(2) AFTER CARE OF YOUNG BUDDINGS

(a) *Treatment of pruning cuts at the union of scion and stock.*

In view of the difficulty experienced in obtaining satisfactory "healing over" at the union in buddings made on large stocks, further experiments were carried out during the year. The experiments included a study of the influence of the slope of the final pruning cut, tests of various protective dressings and the influence of shading on the rate of callus growth at the union. Though the studies are not yet completed the results obtained give the following indications.

(i) On large stocks the slope of the pruning cut appears to be an important consideration. The optimum angle of slope is found to be not less than 45 degrees and, on stocks of more than 4 inches in diameter at the point of union, an even steeper slope appears to be desirable. It has further been demonstrated that the highest point of the final pruning cut should be slightly below the level of the upper edge of the scion.

(ii) Provided that the correct angle of slope is obtained at the final pruning the use of an asphalt-kerosene mixture, as recommended in the Journal of the Institute Vol. 3 p. 35, gives fairly good results. The rate of callus growth is slow however, and this is probably accounted for by the high temperatures attained by a dull black surface in direct sunlight. If the surface can be effectively screened from the sun the rate of callus growth is accelerated.

(iii) Further tests with a wax-sulphur mixture, although giving promising results in the early stages,

have shown this form of wound dressing to be unsuitable for general use. Unless perfect shading of the pruned surface can be maintained throughout the "healing over" period there is every danger that the wax will melt, penetrate the developing callus finally killing new callus and bark to a level considerably below the surface of the pruning cut.

(iv) So far, the best results have been obtained by making a careful pruning cut at the correct slope and level as described in (i) above, paring the surface smooth with a sharp knife, and leaving it untreated.

To confirm these observations further work is necessary and no definite recommendations for practice will be issued until the experiments are concluded.

C. C. T. Sharp

(3) PLANTING OF BUDDED STUMPS

(a) In the Annual Report for 1931 (p. 60) experiments on the transplanting of stumps were described. Further observations and measurements made during the current year have confirmed the results of the early experiments. With the clones used, namely clones A.V.R.O.S. 50, Pilmoor A.44, and B.84, the dormant budded stumps transplanted with the lateral roots from six to twelve inches long, have made by far the best growth during the first eighteen months from transplanting. A separate account of this work has been prepared for publication.

L. E. Morris

(b) *Transplanting of 'stumped' Buddings*

In the planting of 'supplies' in established budded areas 2 to 3 years of age, experiments have been carried out with stumped buddings. Well grown buddings about one year old are pruned at a height of 10 to 12 inches from the union and, after a week to ten days, when the uppermost buds show signs of breaking, transplanting is carried out. Large planting holes, at least 2½ ft. cube, are required to accommodate the well developed root stocks. The method has been tested with clones B.D. 5. and A.V.R.O.S. 50 and has given excellent results. By cutting the buddings at a low level as described, any irre-

gularity in the trunk which may develop as a result of cutting back occurs at a sufficiently low level not to interfere with subsequent tapping when the trees are mature. The advantage of the method in supply planting of established budded areas lies in the greater certainty of successful establishment and more vigorous growth of the supply plants than is obtained by the more usual methods of planting buddings.

H. W. Foston

(4) STUDIES ON THE GROWTH OF BUDDED TREES

(a) *Comparison of the growth of buddings of different clones under the same conditions on virgin soil.**

In November 1929 a clone trial plot was established on the Institute Experiment Station (Block 5) in order to provide material for a critical study of the characteristics and ultimate economic value of some of the best clones available for large scale commercial planting. In continuation of previous reports a summary of the growth records at the end of 1932 is given in Table I. For the purpose of comparison, the corresponding records for 1931 are recapitulated.

TABLE I. *Comparison of growth of buddings of nine clones under uniform conditions (R.R.I. Experiment Station. Block 5)*

Clone			Mean girth per tree in inches		Mean spread of branches in feet	
			Dec. 1931	Dec. 1932	Dec. 1931	Dec. 1932
A.	A.V.R.O.S	152	5.6	8.7	3.2	8.4
B.	"	49	6.4	9.6	4.0	8.5
C.	Prang Besar	23	5.0	7.9	3.1	7.9
D.	"	186	6.7	10.4	5.1	9.8
E.	Bodjong Datar	5	5.6	7.8	1.8	3.3
F.	Tjirandji	1	5.9	9.4	4.0	9.1
G.	Pilmoor	A.44	6.0	9.0	2.5	7.3
H.	"	B.84	6.1	10.0	5.1	10.1
J.	A.V.R.O.S.	50	5.8	8.8	2.5	7.5

*Progress reports on this work have appeared in Annual Reports of the R.R.I., 1929, p. 54; 1930, p. 59; 1931, p. 54.

All clones show a satisfactory rate of growth, clones P.B. 186 and Pilmoor B. 84 being exceptionally vigorous. Clone B.D. 5 shows the poorest development at the end of the third year and this is undoubtedly accounted for by the late branching habit of the buddings of this clone. All trees of B.D. 5 "wintered" severely at $2\frac{1}{2}$ to 3 years of age and wintering was followed by a prolific development of small lateral branches. Clone A.V.R.O.S 152 growing on the open sandy soil of the Experiment Station appears to be less vigorous than it is on the deep lateritic and clay soils on other estates.

(b) *Comparison of the growth of buddings of different clones under uniform conditions on a replanted area.*

In 1930 a further clone trial plot of approximately 40 acres was established on an outside estate in Selangor. The experimental area was originally planted with rubber in 1903. Drastic tapping was practised during 1929 and in early 1930 the area was felled and prepared for replanting. Planting was completed in October 1930 with budded stumps of six clones, five of which are included in the clone trial block on the Experiment Station. In the initial stages, growth of the young buddings was good and compared favourably with that of the buddings on virgin soil. Later development has been much slower as the results summarised in Table II clearly demonstrate.

TABLE II. *Comparison of growth of buddings on virgin and replanted areas of similar soil type.*

Height measurements taken $1\frac{1}{4}$ years from planting

Girth " " $2\frac{1}{4}$ " " "

Clone		Height in inches at $1\frac{1}{4}$ years			Girth in cm. at $2\frac{1}{4}$ years.		
		A on replanted area	B on virgin soil	Ratio $\frac{B}{A}$	A on replanted area	B on virgin soil	Ratio $\frac{B}{A}$
A.V.R.O.S.	49	59.2	113.5	1.9	8.0	17.1	2.1
"	50	70.1	93.8	1.8	8.0	15.3	1.7
Bodjong Datar	5	57.8	85.8	1.5	8.8	14.7	1.7
Tjirandi	1	58.3	92.5	1.6	8.2	15.9	1.9
Pilmoor	B. 84	53.6	110.8	2.1	7.7	16.2	2.2
Glenshiel	1	64.2	—	—	8.5	—	—

It is of interest to note that clone B.D. 5, which shows relatively poor growth on the Experiment Station trial plot, appears to be one of the most vigorous clones on the replanted area. The results to date indicate that, in order to promote vigorous growth in the early stages of the development of replanted areas, special methods of cultivation and possibly manuring will be necessary. The choice of suitable clones will also be of considerable importance.

C. E. T. Mann

(c) *Comparison of the growth of buddings of proved clones under different conditions on estates.*

In order to supplement the data obtained from the detailed field experiments, described under (a) and (b) above, early in the year a request was forwarded to a large number of estates asking for growth measurements on representative groups (50 to 100 trees each) of buddings of different clones. Some 50 estates responded to our request and have forwarded the required data. The records have been examined and the main features of interest are briefly described.

Growth measurements of budded trees of several of the oldest established clones, now recommended for mono-clone planting, have been obtained on trees of various ages, ranging from six months to four years, and growing on a wide range of soils. Clone A.V.R.O.S 49 shows a high degree of uniformity and vigour of growth above the average.

Clones Bodjong Datar 5 and 10 show similar pronounced uniformity. On the other hand clone A.V.R. O.S. 152 appears to be very sensitive to soil conditions and shows the least degree of uniformity of any clone recorded. Growth appears to be particularly bad where natural grasses are allowed to remain in the ground cover and this also applies to clone A.V.R.O.S. 50. The latter clone shows less variable growth than clone A.V.R. O.S. 152 but is much less uniform than clone A.V.R.O.S. 49. Of the more recently developed clones we have obtained fewer records but the general indications are that clones Prang Besar 186 and 23, Sungei Reko 9, and Tjirandji 1 all show very uniform growth under the different conditions recorded. Clone P.B. 23 is particularly interesting; the early records show the growth of this clone to be variable and generally weak. From the second year onwards there is a marked increase in vigour and a

general evening-up in growth and this is most probably accounted for by the prolific branch and crown development which takes place at this stage.

If we assume that budded trees with a girth of 20 inches at a height of 40 inches from the union may be considered tappable then it is estimated from our records that, under average conditions, buddings of the following clones will be tappable at the following ages. Clones A.V.R.O.S. 49, Tjirandji 1, P. Besar 186 and 23:— $4\frac{1}{2}$ to 5 years (from the date of budding in the field.) Clones A.V.R.O.S. 50 and 256, Sungei Reko 9 and Bodjong Datar 10:—5 to $5\frac{1}{2}$ years. Clone Bodjong Datar 5:— $5\frac{1}{2}$ to 6 years. As already indicated clone A.V.R.O.S. 152 is extremely variable and may mature as quickly as A.V.R.O.S. 49 or as slowly as B.D. 5 in accordance with the favourability or otherwise of local conditions. Buddings of clone B.D. 5, though vigorous in early growth, branch very late in the second year and the slow rate of girth increase is undoubtedly related to this peculiarity in habit.

C. C. T. Sharp

(d) *Influence of density of planting on the growth and development of budded trees.*

In December 1930 an experiment was laid down to test the effect of density of planting on the growth and future yield of buddings (R.R.I. Experiment Station, Block 14, 40 acres). Since clone A.V.R.O.S. 50, a clone with a long and satisfactory record had been selected as a "control" clone in previous experimental blocks this clone was used in the present experiment. The area is subdivided into 36 plots and six different densities of planting are being tried. The arrangement of plots is on the latin square system. A summary of growth data is presented in Table III.

The records to date indicate that the poorest growth is found in the widest planted plots and the best growth occurs in those most densely planted. These records will be continued until the trees reach tappable size when a full account of the work, together with the necessary statistical analysis of the complete records, will be published separately.

TABLE III. *Density of planting and growth of budded trees of clone A.V.R.O.S. 50*

Plots	Planting Distance in feet.	No. of trees per plot	Records of Growth		
			Mean Height in ins.		Mean Girth in cms.
			Dec. 1931	July 1932	Dec. 1932
A	30 x 30	54	91.0	150.5	12.3
B	20 x 20	117	96.8	159.2	13.0
C	14 x 14	247	94.8	157.2	12.4
D	12 x 12	320	98.5	160.2	12.9
E	10 x 10	468	101.2	169.3	13.3
F	20 Δ	125	97.3	163.2	13.0

C. E. T. Mann

(e) *Growth and performance of budded trees in mixed plantings*

In the earliest plantings with budded trees, buddings of a number of clones were interplanted with an equal number of 'selected' seedlings. Later, only buddings of a number of clones were used in mixed planting and seedlings were omitted. Finally, monoclonal planting of the best clones available has become the general practice, at least in Malaya.

In order to study growth and future development of the trees in plantings of these different types, experimental blocks have been laid down on the Institute Experiment Station (Blocks 17A, 17C, 17D and 22.) Growth measurements have been made periodically and already there are strong indications that the buddings of the less vigorous clones, which may prove to be some of the highest yielders eventually, are being seriously suppressed by the more vigorous seedlings or buddings of stronger growing clones.

F. Billington & C. E. T. Mann

(f) *Estate experiments*

During the year visits of inspection have been paid to the various estates on which experimental work was started in 1928 and early 1929. These experiments were laid down with the object of comparing newer Malayan clones under different conditions. Certain of the older A.V.R.O.S. clones, notably A.V.R.O.S. 50 and 152, were included for the purpose of comparison.

Although all the experimental areas are being maintained in good condition, owing to the necessity for economy in all directions it has not proved possible to carry out the detailed observations and measurements originally intended. The experimental areas on Gunong Kroh Estate (Perak) Lubok Segintah Estate (Kedah) Changkat Kinding Estate (Perak) Pilmoor Estate (Selangor) are approaching tappable age and it is hoped to commence test tapping towards the end of 1933.

C. E. T. Mann

(5) THE MUTUAL RELATIONSHIP BETWEEN SCION AND STOCK IN BUDDED TREES

(a) *Influence of stock vigour on growth of scion*

In the Annual Report for 1931, p.58, observations on the rate of growth of buddings made on stocks of varying vigour were reported. In that investigation the stocks were budded at the age of 20 months and at the time of budding hardly a single plant was more than 2 inches in diameter at the budding point, the average diameter being about $1\frac{1}{4}$ inches. Under these conditions a close relationship between stock size and scion growth was demonstrated.

TABLE IV. *Correlation between stock size and growth of scions in different clones.*

Clone		No. of Trees	Mean girth of stocks at time of budding. inches.	Mean height of scions after 9 months. feet ins.		Correlation between girth of stock and growth of scions.
Tjir.	16	201	7.0	6	3	+ .082
A.V.R.O.S.	71	229	7.0	5	9	+ .002
B.D.	10	186	6.7	6	6	+ .256
S.R.	9	204	6.7	6	0	+ .219
A.V.R.O.S.	256	170	7.1	6	5	+ .090
Ct. Java	88	218	6.5	5	10	+ .309
Avros.	50	221	6.8	6	6	+ .102
All clones		1429	6.8	6	2	+ .202

To test this point further, similar measurements were made on a second budded area (Block 21) where the

stocks at the time of budding were two years of age and showed much more vigorous growth than those in the first experiment (Block 3.)

The stocks were measured at the time of budding and the growth of the scions measured 9 months after budding.

Correlation coefficients were worked out to show the relationship between growth of scion and vigour of stock, as indicated by measurements of girth at the time of budding.

The figures summarised in Table IV indicate a low degree of correlation between stock vigour and growth of scion and it would appear that the rather close relationship observed when buddings are made on relatively small stocks does not hold for buddings made on older and larger stocks. It is possible that a closer relationship may be found as the trees increase in age.

Further investigations are in progress.

F. Billington

(b) *Influence of scion on yield of stock*

In order to discover whether a scion may influence in any way the latex producing capacity of the stock below the union, normal seedling trees have been budded at varying heights from ground level up to four feet. It is proposed to tap these trees at a uniform height so that comparisons may be made between the yields from tapping cuts situated at varying distances from the point of junction of scion and stock. This work also forms part of the main investigation of the physiology of the rubber tree in relation to latex production.

C. E. T. Mann & C. C. T. Sharp

A second method of approach to the same problem is to utilise the method known as 'twinning' in order to produce two plants from a single seed. The plants so produced should be genetically identical and, under the same conditions, should have the same latex producing capacity. One member of each twin is budded, the other remains unbudded. Growth and ultimate yield performance of the two trees of each pair will be studied. During the year over 1000 twins, grown from illegitimate seed from good clones, have been planted in permanent plots on the Experiment Station.

Budding of older pairs of twin plants, established in 1929 and 1930, has been completed and the trees are making good growth.

C. E. T. Mann & K. N. Kaimal

(c) *Use of special stocks for budding with Hevea brasiliensis.*

Hevea spruceana is known to grow vigorously under conditions which are not favourable to *H. brasiliensis*, the former species grows well in regions which are liable to be flooded for considerable periods during the year. It is possible therefore that *H. spruceana* seedlings may prove valuable as stocks for *H. brasiliensis* under certain conditions. In order to obtain seed of *H. spruceana* to raise stocks for budding, isolated plots in forest reserve have been established. Plot A. contains only buddings of *Hevea spruceana* from which pure seed will be obtained. Plot B. contains equal numbers of buddings of *H. spruceana* and seedlings of *H. brasiliensis* and from this plot it is hoped to raise hybrid material. Budding was successfully completed in November—December.

C. E. T. Mann

(d) *Study of the latex vessel systems in scion and stock.*

The investigation of bark samples from 19 clones established on the Pilmoor Estate experimental area, has now been completed. Sections of the virgin bark taken at heights of 1 inch below the union and at 1 inch, 20 inches and 40 inches above the union have been examined.

The detailed results will be published separately; the following are the main conclusions.

Considering first the latex vessel systems immediately above and below the union, if the clones are grouped in the order of the number of latex vessel rows in the stock it is found that the first seven clones in the list are also the seven highest yielding clones. It is also found that 12 clones show a larger number of latex vessels in the stock than in the scion immediately above the union; 5 clones show an equal number of vessels in stock and scion and 2 clones show a larger number of latex vessels in the scion than in the stock.

Within a clone, comparing the numbers of latex vessels immediately above and below the union in indivi-

dual trees no very close degree of correlation is observed, neither is there a close relationship between the number of vessels found at 1 inch and 20 inches from the union.

There is however, a very high degree of correlation between the number of vessels at 20 inches and the number at 40 inches from the union.

These results indicate that, in the region of union of stock and scion, there is a profound disturbance in the organisation of the latex vessel system of the tree. The significance of these findings will be further investigated by means of tapping experiments.

K. N. Kaimal

2. The Physiology of *Hevea brasiliensis* in Relation to Latex Production

Since all those factors which influence the life processes of a rubber tree must have an important bearing on the capacity of the tree to produce latex, the 'physiology of latex production,' a convenient but clumsy phrase, covers a very wide field. From the economic standpoint, we are concerned chiefly with the power of the tree to produce latex in response to controlled wounding, i.e. tapping. Though it is fully appreciated that the direct study of the normal life processes, such as transpiration, carbon assimilation or the course of translocation of food materials, may throw important light on the physiology of the rubber tree yet these fundamental processes are profoundly influenced by environmental factors that cannot be economically controlled. From the economic standpoint the indirect method of attack appears the most promising. The tapping process in itself provides a valuable means of investigating important physiological problems and an intensive study of the reactions of the tree to various methods of tapping is likely to yield valuable information concerning the functions and composition of latex. At the same time, by tackling the problem of latex production in this manner it seems more than likely that methods of great practical importance may be developed which are capable of immediate application even though the exact physiological reasons for their success may not be fully understood. It is for this reason that much of the experimental work reported in the present section is concerned with tapping investigations. At the same time it must be made clear that other investigations such as the study of wound healing, as in vegetative propagation and the study of bark renewal, the utilisation of

the response to wounding in selection work and the biochemical study of the product obtained from the tree by different tapping methods, are all physiological studies bearing on the main problems of latex production.

(1) TAPPING EXPERIMENTS ON MATURE TREES GROWN FROM SEED

(a) *Lake Gardens experimental area*

By arrangement with the Department of Agriculture S.S. & F.M.S., the Rubber Research Institute has obtained control of an area of 35 acres of mature rubber of about thirty years of age. A survey of the area was made in collaboration with the Head of the Soils Division of the Institute and subdivision into plots on an ecological basis was made. In order to establish the basic value for each plot from the standpoint of yield, a general tapping of the whole area on a uniform system, alternate daily tapping on half circumference, was started in November, 1932. Individual tree records are being taken and the total yield for each plot obtained. Conditions vary considerably over the area and a wide range of material, suitable for small scale experimental work is represented. For example, one portion of the area contains mature trees which have never been tapped and are growing in secondary jungle while, on an adjoining area, on a steep slope, are trees of comparable age which appear to have been grown under conditions of clean weeding without recourse to any special methods of soil conservation and which have been drastically tapped in the past. The effect on yield of various methods of soil improvement by means of natural regeneration of the ground flora is being studied in conjunction with a botanical study of the various plant species which make their appearance in the course of repopulation of eroded soils. On suitable portions of the area small scale tapping experiments have been started to compare a number of different tapping systems and to provide material to supplement the work in progress on a plantation scale elsewhere (See subsection (b) below).

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(b) *Economic tapping systems*

A considerable amount of time has been devoted to the study of the economics of tapping practice with the

object of developing new tapping methods which may, without detriment to the tree, result in a reduction in tapping costs.

The scheme of experimental work proposed, provides for the careful comparative study of the following systems of tapping.

1. A.B.C. 6 months tapping, 3 months rest.
2. A.B.C. 10 months tapping, 5 months rest.
3. A.B.C. 14 months tapping, 7 months rest.
4. Two cut, 3rd. daily tapping, 3 months tapping, 3 months rest.
5. Two cut, 3rd. daily tapping. 5 months tapping, 5 months rest.
6. Two cut, 3rd. daily tapping. 7 months tapping, 7 months rest.
7. Two cut, 4th. daily tapping. ("Double-four").
8. Alternate daily tapping without rest periods.

The scheme also provides for the study of the influence of the tapping system on the chemical and physical properties of latex and the possible relationship between these properties and the quality of the manufactured rubber. This side of the work will be conducted in close collaboration with the Chemical Division.

In addition to the physiological study, morphological studies, particularly in relation to bark renewal, will be carried out and it is in order to provide suitable material for this work that the supplementary small scale experiments mentioned under (a) have been initiated.

The area required for this series of investigations is approximately 250 acres, divided into six plots to allow for six replications of each series of tasks on each of the eight tapping systems.

C. C. T. Sharp

(c) *Tapping experiments on estates*

The pressing need for economy in every stage of production has stimulated interest in departures from the generally accepted methods of tapping. In particular, various forms of 'double-cut' tapping have claimed attention. The simplest form of double-cut tapping is that popularly known as the Sunderland System from its origin on Sunderland Estate in Ceylon. On this system, tapping is carried out with two cuts, each cut on half the circumference of the tree, on opposite tapping panels

and at different levels. Tapping on both cuts is carried out every third day for six months and the trees are then rested for six months. This simple form of double-cut tapping may be modified by varying the length of the tapping and rests periods. The length of the interval between tapings may also be varied and in this connection the "double four" system i.e. tapping two cuts, one on each side of the tree every fourth day has received attention. It is impossible in the present report for reasons of space to give details of the numerous estate experiments that are being conducted on these new tapping systems but we wish to record our appreciation of the facilities granted us for careful study of double cut tapping systems by Mr. S. B. Palmer, Bruas Estate, Perak; Mr. J. C. Innes, Straits Rubber Company Ltd. and Allied Companies; Mr. J. Murray and Mr. C. H. Green, Tuan Mee Rubber Co., and Mr. A. P. Cranna, Messrs. Guthrie & Co. Ltd.

In the accompanying table the results so far obtained in typical experiments are summarised.

The results summarised above may be taken as being fairly representative of the general experience on estates. The work is not yet sufficiently advanced to allow of definite conclusions or recommendations for practice but this early work indicates that:—

- (a) There is a definite reduction in tapping costs. The mean figure is 25%, the best result being obtained on the oldest rubber where a saving of over 30% in tapping costs is recorded.
- (b) In the early stages there may be a loss in crop of about 25% but there is every indication that, as the benefits of the long rest periods make themselves felt, the actual loss in yield, as compared with the yield obtained by normal alternate day tapping on a single cut, will diminish.
- (c) The best results are obtained on the most mature trees.

Similar experiments have been conducted on young rubber from 6 to 8 years of age but so far the results are much less promising than those obtained on well developed mature trees.

TABLE V. *A summary of the results of some estate experiments with double-cut tapping systems.*

No. of Experiment	Age of Trees in years	Tapping Systems Compared		Duration of Experiment months.	Comparison of Yields (Dry rubber)				
		Experimental System	Control System		Pounds per acre over period of experiment		Pounds per tapper		Ratio. Experiment Control
					Experiment	Control	Experiment	Control	
1	25	2 cuts 3rd. daily, $\frac{1}{2}$ circumference, V cuts. 6 months tapping 6 months rest.	Continuous alternate daily tapping on single half circumference 'V' cut.	12	498	457*	17.7	12.1	109
2	22	2 cuts 3rd. daily, $\frac{1}{3}$ circumference 1. to r. spiral cuts 8 months tapping 8 months rest.	Continuous alternate day tapping on single one third circumference spiral cut.	8	349	362	22.7	17.2	96
3	14	As in Experiment 1	As in Experiment 1	5	212	256*	17.3	13.0	83
4	12	As in Experiments 1 & 3	As in Experiments 1 & 3	8	303	395	16.5	12.3	77
5	11	2 cuts. 3rd daily, $\frac{1}{2}$ circumference, V cuts. 8 months tapping 4 months rest.	Continuous alternate day tapping on single half circumference V cut.	8	378	484	13.6	12.3	78

*Note In experiments 2, 4 & 5, yield records of comparable areas on the normal system of tapping were taken on the same day as for the experimental tasks.

In experiments 1 & 3 the yield records for the experimental areas during the corresponding period of the previous year are given. The comparison of experimental and control yields must not be given too much importance in these cases.

(2) TAPPING EXPERIMENTS ON BUDDED TREES

(a) *Pilmoor Estate experiments*

The investigations on tapping of budded trees, commenced in January 1928, have been continued and extended during the year. The systems of tapping and methods of collection, manufacture of the crop and recording of the yields were the same as in 1931. Two systems of tapping are employed:—viz

A. Alternate daily tapping.

B. Daily alternate monthly tapping.

For both groups of trees the tapping panel was opened at a height of 36 inches in April 1929 and completed in December 1932.

Except for 3 months rest, February to April 1930, tapping has been continuous.

The progress of yield increase over the 5 years of these experiments is best appreciated by reference to Table VI.

TABLE VI. *Summary of yield records of the Pilmoor Clones*

Year	Average age of trees	Yield in pounds dry rubber per tree per annum										
		A. 44		B. 58		B. 84		D. 61.		B. 16		D.65
		a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.
1928	3½	4.4	—	2.6	—	3.8	—	—	—	—	—	—
1929	4½	6.0	5.5	4.2	4.8	5.2	6.9	5.1	—	5.5	4.9	4.5
1930	5½	6.6	6.6	7.2	6.8	7.1	8.1	6.3	6.2	8.7	8.1	11.0
1931	6½	7.1	8.0	8.7	9.0	9.2	11.3	8.2	8.8	11.4	11.8	15.9
1932	7½	8.2	9.6	10.2	10.6	12.3	14.3	9.5	10.9	13.0	13.4	19.0

a.d. = Alternate daily tapping:—Group A.

d.a.m. = Daily alternate monthly tapping:—Group B.

For previous reports of these experiments see

Annual Report R.R.I. of Malaya 1928, p. 41 — 42.

Idem " " 1929, p. 51 — 52.

Idem " " 1930, p. 64 — 67.

Idem " " 1931, p. 64 — 66.

It will be noted that for all clones, except B.84, the actual yield per tree is approximately the same on either system of tapping. The records have been carefully examined by statistical methods and it is demonstrated that the small differences in yield are without significance.

In clone B. 84 however, there is an appreciable difference in yield on the two systems of tapping which is fully significant.

Up to May 1932 the number of trees tapped in each group was the same as in 1931; from May 1st. the trees in certain clones were divided into two groups on an equivalent girth basis and half of the trees were tapped on a new panel opened at a height of 40 inches from the union on the opposite side of the tree.

The yields of all clones have shown a satisfactory increase but clones D. 65 and B. 84 are outstanding.

Determinations of the dry rubber content of the latex from each group of trees are made on each tapping day.

The average figures for 1932 are summarised in Table VII.

TABLE VII. *Dry rubber content of latex of the Pilmoor Clones during 1932.*

Tapping level	Dry rubber content, per. cent.										
	A. 44		B. 58		B. 84		D. 61		B. 16		D. 65
	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.
Low Cut (10 to 2 ins. from union)	37.7	36.8	43.0	37.3	39.0	35.2	32.7	33.9	37.9	36.1	34.5
High Cut (40 to 32 ins.) from union	37.4	37.9	41.1	38.2	35.4	32.5	—	—	38.3	35.5	—

For all clones, with the possible exception of clone D. 61, the d.r.c. of the latex on all groups is satisfactory. Clone B. 58 gives a latex with an exceptionally high d.r.c.

TABLE VIII. (a) *The rate of bark consumption in tapping budded trees*
 (b) *Rate of bark renewal in budded trees.*

Clone	A.44		B.58		B.84		D.61		B.16		D.65
	a.d.	d.a.m.	a.d.	d.a.m.	a.d.	d.a.m.	a.d.	d.a.m.	a.d.	d.a.m.	a.d.
Bark consumption in vertical inches per month.	0.80	0.88	0.85	0.89	0.75	0.84	0.78	0.78	0.77	0.85	0.79
Thickness of virgin bark at height of 40 ins.	7.7	7.7	7.5	7.3	9.0	9.0	—	—	9.1	9.1	8.3
Thickness of renewed bark at height of 20 ins. after 4 years renewal.	6.4	6.9	7.9	7.5	9.5	9.5	—	—	* 7.7	* 7.2	9.0

*Clone B16—renewal period 3 years.

Bark Consumption

Throughout the whole period of test the consumption of bark has never been strictly controlled. The tappers have been encouraged to do good work but, since the bark characters of different clones may vary sufficiently to affect the ease of tapping, it was considered advisable to carry out the tapping tests in such a manner that differences of this nature should not be masked. That such differences between clones may exist is illustrated by the data presented in Table VIII.

Bark renewal

Measurements of bark thickness of both virgin and renewed bark were made in May 1932 (measurements taken in millimetres). The figures for virgin bark thickness and those for renewed bark after 4 years are given in Table VIII. Clone A. 44 shows the poorest rate of renewal but for all other clones a very satisfactory renewal rate is shown. It is noteworthy that the best yielding clones, B. 84 and D. 65 show the most satisfactory rates of bark renewal.

Incidence of disease

The general health of the trees is excellent and there has been no further incidence of brown bast during the year. The present position in regard to brown bast is summarised in Table IX.

TABLE IX. *Incidence of brown bast in Pilmoor clones*

Clone	Total No. of Trees	Cases of Brown Bast		Total trees affected	Trees affected per cent.
		Alternate day tapping	Daily tapping Alt. months		
A. 44	88	4	4	8	9.1
B. 58	64	1	2	3	4.7
B. 84	35	2	2	4	11.4
D. 61	24	2	2	4	16.7
B. 16	65	5	3	8	12.1
D. 65	4	0	0	0	Nil

It is of interest to note that the highest incidence of brown bast is found in Clone D. 61. The mother tree

of this clone was specially selected as a brown bast subject with a very high yield.

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(b) *Influence of tapping height on the yield of budded trees*

(i) Since May 1932 tapping of budded trees of the Pilmoor Clones A. 44, B. 58, B. 84, and B. 16 has been carried out on the two systems described above and at two tapping heights, viz from 8 inches down to the union, and from 40 inches down to 32 inches.

The yield records are summarised in Tables X. and XI.

TABLE X. *Yields from high and low cuts in grms. dry rubber per tree per tapping.*

Trees tapped alternate daily.

Clone	A.44		B.58		B.84		B.16	
No. of trees	21	18	17	14	8	8	18	18
Height of cut	High	Low	High	Low	High	Low	High	Low
May 1932	19.1	17.5	19.4	26.6	24.0	33.5	27.0	31.6
June „	26.8	21.3	28.3	31.1	38.4	39.7	40.0	36.9
July „	27.8	23.5	26.7	31.4	43.5	47.4	39.3	40.1
Aug. „	28.2	29.3	29.2	35.9	45.1	42.1	41.4	36.8
Sept. „	29.5	21.9	31.9	32.6	39.7	40.5	46.1	39.3
Oct. „	27.0	21.9	29.3	28.5	37.7	37.8	46.2	40.7
Nov. „	28.2	19.9	32.3	28.1	41.2	37.0	46.3	36.5
Dec. „	27.7	20.3	23.3	26.4	42.5	38.3	44.2	33.4
Average per tree per tapping	26.8	22.0	28.8	30.1	39.0	39.5	41.3	37.0

TABLE XI. *Yields from high and low cuts in grms. dry rubber per tree per tapping.*

Trees tapped daily in alternate months

Clone	A.44		B.58		B.84		B.16	
No. of trees	19	18	17	17	10	8	17	15
Height of cut	High	Low	High	Low	High	Low	High	Low
May	27.4	25.7	24.0	26.9	34.9	36.2	33.4	34.3
July	32.5	27.7	31.4	29.2	51.0	49.5	45.9	35.1
September	31.5	27.8	36.4	31.9	57.7	49.7	45.1	40.7
November	31.6	25.5	35.9	30.1	48.5	38.9	40.2	38.2
Average per tree per tapping	30.8	26.7	31.9	29.5	48.0	43.6	41.2	37.1

The results presented in Tables X and XI show that, with budded trees, as the tapping cut approaches the union there is a gradual decrease in yield. It will be noted that whilst the yields from the low cuts tend to decrease those from the high cuts tend to increase.

Although this general statement holds good there are clear indications that clones react differently to these changes and these differences will be discussed in the detailed account of this work. The determinations of d.r.c. of the latex, summarised in Table VII., show significant differences, both between clones and between the groups of trees of the same clone under different treatments. A careful study of these differences and their possible relation to the chemical and physical properties of the latex forms a major line of research by officers of the Chemical Division with whom the closest contact is being maintained.

It is extremely interesting to note that the differences between the mean yields on high and low cuts for each clone over the whole period are not large. Below the upper cut there is a deep zone of scion bark supplying

latex to the cut, below the lower cut the latex supply is drawn from a small zone of scion bark and presumably from the latex vessel system of the stock below the union. These observations suggest that the high yielding scion has a profound influence on the latex producing capacity of the stock. If this fact can be established by further study then an important advance in our knowledge of the physiological principles which govern the production of latex will be made.

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(ii) A further investigation of interest in this connection is the study of the Heusser system of tapping on clone Glenshiel 1. In this system two tapping cuts are employed and are both tapped on the same day. Each cut is on $\frac{1}{4}$ circumference; one cut is opened at a height of 40 inches and the other on a panel immediately to the left of the first, at a height of 80 inches.

Since June 1931 individual yields from a group of 20 trees have been recorded, the yields from upper and lower cuts being recorded separately. Until February 1932 the yield from the lower cut exceeded that from the upper cut. From February 1932 until October 1932 there was no significant difference between the yields at the two tapping levels. In November the yield of the upper cut definitely exceeded that from the lower cut which at this stage was only an inch or two above the level of the union of stock and scion. The yield of the upper cut is still rising whilst that of the lower cut is definitely falling. There is no doubt that the underlying causes for this are the same as those involved in the experiments in (i) above on the Pilmoor clones.

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(c) *The influence of the tapping systems on the yield of budded trees.*

In addition to the experiments carried out on the Pilmoor clones, to compare alternate daily and daily alternate monthly tapping systems, further studies on the same subject have been carried out on Glenshiel Estate on budded trees of clone Glenshiel 1*. Tapping was

*For previous reports on these experiments see:—

Annual Report R.R.I. of Malaya 1930 p. 67 — 70.

” ” ” ” ” 1931 p. 66 — 67.

TABLE XII. Influence of the tapping system on the yield of budded trees of clone *Glenshiel 1*

Group	No. of Trees	Tapping System	Mean Girth in inches at 40 inches from union.			Mean Yield in grams dry rubber per tree per tapping			Yield expressed as percentage of Yield of Group I. (Control = 100)		
			1930	1931	1932	1930	1931	1932	1930	1931	1932
I.	20	Alternate daily $\frac{1}{2}$ circ.	32.6	34.0	36.2	64.4	63.5	63.1	100	100	100
I. A.	20	Alternate daily $\frac{1}{2}$ circ. (Tapped when I is resting)	31.5	32.5	34.0	64.7	65.7	57.0	105	103	90
II.	20	(a) Daily alternate monthly.	32.6	33.0	37.3	67.0	64.4	55.1	105	101	87
		(b) See footnote below table.			35.9			55.0			87
III.	20	Daily in alternate fortnights. $\frac{1}{2}$ circ.	33.5	33.5	36.2	65.0	66.8	54.1	102	105	86
IV.	20	Heusser System 2 cuts on $\frac{1}{4}$ circ. Alt. daily	32.5	33.0	36.0	66.9	70.0	67.0	105	110	106
V.	20	Alternate daily on $\frac{1}{3}$ circ.	32.0	33.0	35.2	55.0	60.8	55.1	92	96	87
VI.	20	Daily alt. fortnightly on $\frac{1}{3}$ circ.	32.0	33.0	35.5	45.0	52.8	51.9	75	83	82

(b) *Group II.* Daily alternate monthly tapping was carried out from June 1930 to June 1931.Incidence of brown bast symptoms and pronounced fall in yield in June '31 showed that this system of tapping was unsuitable for the clone. Accordingly, from July 1st, 10 trees were tapped alternate daily on $\frac{1}{3}$ circ. and 10 trees alternate daily on $\frac{1}{2}$ circumference.

continued on the same tapping panels as in 1930 and 1931, until October and November when, in all groups, except II and III, a new panel was opened.

Details of the various systems of tapping under test with a summary of the results to the end of 1932 are given in Table XII.

The figures show that during 1931 there is a small but general decrease in yield of all groups. Seasonal differences may be in part responsible for this but the evidence from the experiment on the Heusser system suggests that the approach to the union of scion and stock is most probably the chief factor.

The relatively high yields in those groups of trees tapped on $1/3$ circumference cuts is of particular interest. It may be found by extended trial that tapping alternate daily on $1/3$ circumference may be the best method of tapping this clone commercially.

The conduct of these experiments on Glenshiel Estate has only been made possible by the very generous co-operation of Mr. J. H. H. Bailie and Mr. W. A. D. Wynch, who have personally supervised the field and clerical work involved. We wish to record our appreciation of their keen interest and valued assistance.

C. E. T. Mann

(d) *Yields of young buddings from old established clones.**

We have no reason to believe that the high yielding qualities of budded trees will not be reproduced in successive 'vegetative generations' established by multiplication from the original buddings of a clone. At the same time, direct proof is needed and experiments with the object of obtaining this have been carried out.

On Pilmoor Estate, young buddings of clones A. 44 and B. 84, made from the first buddings of these clones, were established in 1928. In April 1932, girth measurements were taken and two groups of 20 trees, of comparable girth with the original trees of each clone, were selected for tapping tests. Tapping was carried out alternate daily in alternate months using a left to right spiral cut over half circumference commencing at 20 inches above the union. This was the system used for the original test-tapping of the first 'vegetative generation' trees in 1928.

In Table XIII the yield records are summarised and, for comparison, the corresponding records for the trees of the first 'vegetative generation' are included.

TABLE XIII. *Comparison of yields of budded trees of the first and second 'vegetative generations'*

Tapping Period	Clone A. 44		Clone B. 84	
	1st. Generation 1928	2nd. Generation 1932	1st. Generation 1928	2nd. Generation 1932
1	8.9	7.9	2.8	2.3
2	8.9	9.2	6.6	4.3
3	10.7	12.2	9.0	6.9
4	13.0	15.1	11.6	7.3
Mean yield per tree per tapping in Grms. dry rubber.	10.4	11.1	7.5	5.2

The agreement in clone A. 44 is very close; in clone B. 84 though the agreement is not quite so good, it is satisfactory for trees of this age.

C. E. T. Mann & K. N. Kaimal

III. Selection and Breeding

In the introduction to this report the relative importance of breeding and selection work was discussed and reference was made to the decision to curtail further work in this direction for the present. Accordingly, most of the progress to be reported here concerns the completion of the work of establishing material already developed and the continuation of certain investigations which may be considered to be of immediate importance.

(1) SELECTION OF HIGH YIELDING TREES ON ESTATES AND THE ESTABLISHMENT OF NEW CLONES *

During the year the collection of yield records of high yielding trees was discontinued.

*For previous reports of this work see:—

Annual Report R.R.I of Malaya 1929 p. 45 — 46.

" " " " " 1930 p. 56 — 58.

" " " " " 1931 p. 52 — 53.

For most of the mother trees selected, records have been kept for one and a half to two and a half years. Though it would have been desirable to continue this work of regular recording of the mother trees from which new clones are being established, the necessity for reducing clerical work in the Division and the similar difficulty experienced on many of the estates, rendered this impracticable.

The collection of budwood from the selected trees was completed and buddings of a further 43 clones were established in the field. (Block 15, R.R.I. Expt. Station) in the manner described in the Report for 1931. Budwood of the remaining 43 trees was received too late in the year for the whole block to be completed but it is hoped that the budding of the remaining clones in the field will be completed early in 1933.

The following is a summary of the position at the end of 1932

Source of Material	Trees recorded	No. selected	No. received	No. established in field	No. in nursery
R.R.I. Scheme	164	115	115	114	1
Estate Schemes by Agency Houses	654	105	90	66	24
Recorded independently by estates	50	29	27	22	5
Totals ...	868	249	232	202	30

C. C. T. Sharp

(2) ARTIFICIAL POLLINATION AND BREEDING INVESTIGATIONS

No further new work in pollination and breeding was carried out during the year. Careful recording of the material developed in previous years was continued and from the majority of the crosses established on the Experiment Station, groups of buddings have been made in the manner described in previous reports. The following is a summary of the position of this work at the end of the year.

Cross	Number of seedlings obtained					Number of seedlings from which bud-dings have been made.
	1928	1929	1930	1931	Total	
A.44 x 11	70	278	94	—	442	375
A. 8 x 2	10	—	—	—	10	9
B.50 x 3	—	18	22	—	40	29
B.58 x 11	40	105	85	7	237	136
B.84 x 8	9	122	94	27	252	165
C.72 x 1	—	6	—	—	6	4
B.90 x 1	—	—	35	—	35	—
D.61 x 7	54	131	—	357	542	171
D.65 x 4	—	14	21	—	35	28
B.65 x 1	—	—	9	—	9	9
B.16 x 5	9	36	4	2	51	38
B.95 x 1	9	—	—	—	9	8
B.11 x 1	—	—	12	—	12	—
L.K. x L.N	—	3	—	—	3	2
Totals	201	713	376	393	1683	974

In the summary given above limitations of space prevent the inclusion of more detail. In the list of crosses the female parent is given first and the figures indicate the number of male parents with which successful crosses have been made. On Pilmoor Estate there are four very promising clones and successful crosses have been made between these, using every possible combination of two parents. From the most promising seedlings of every family new clones have been made by the disbudding method or, when development was sufficiently vigorous, by removing a lateral branch and using it as budwood in the ordinary way.

Field observation to date have shown that, as regards appearance and general vigour, some of the families are of outstanding quality. It remains to be seen whether tapping tests, to be commenced in July 1933 on the crosses made in 1928, will reveal latex producing qualities of a similar order.

This brief summary has been prepared by the head of the division though most of the work recorded was completed by Mr. L. E. Morris prior to his departure on leave. In May 1933 Mr. Billington completed the budding of the new clones derived from crosses made in the second flowering season of the year 1930.

L. E. Morris

(3) INVESTIGATION OF METHODS OF NURSERY SELECTION

(i) The seedlings of clones A. 44, B. 50 and B. 58, tested in the nursery in 1931 by means of the Cramer knife, were again tested in the field in November 1932. The results, on the whole, were somewhat disappointing. In the original test in the nursery, three groups of seedlings of each clone were selected:—

- (a) plants showing a very good flow of latex
- (b) a medium flow
- (c) poor flow.

Comparison of the individual plant records for the two tests showed that, in the second test, only 53 per cent. of the plants fell into the original classification. In December, half of the plants in each group were budded with clone P.B. 186, the aim being to discover whether the selection of stocks by this method will have any influence on the performance of buddings made upon them.

C. C. T. Sharp

(ii) Cramer's method has also been applied to twin seedlings to compare the behaviour of the two individuals grown from a single seed. A close relationship between the amount of flow of latex from the two members of a twin was demonstrated. The coefficient of correlation for the flow of latex from the two plants of about 1000 pairs was $+ 0.81$.

These plants have been established in permanent plots and further comparisons will be made when the trees reach the age for test-tapping.

K. N. Kaimal

(4) TEST TAPPING METHODS AND THEIR VALUE IN SELECTION

In continuation of the work described in the report for 1931, (p. 67) test tapping experiments were commenced on the Experiment Station in January 1932 on seedling trees $3\frac{1}{4}$ years of age. (Block 2). Trees having a girth of 12 inches or more at a height of 12 inches from ground level were tapped with a half circumference, left to right spiral cut, commencing at a height of 12 inches.

The following tapping systems are under test:—

Group I.	Trees tapped daily for 30 days.	133 trees
Group II.	„ „ alt. daily for 30 days	124 trees
Group III.	„ „ daily for 15 days	130 trees

Two periods of test tapping were completed; the first in January, the second in July. The comparison of the individual tree yields in the two periods showed that the trees maintained very closely the same relative positions with regard to yield. Examination of the detailed figures also showed that, by taking the total weight of rubber obtained per tree from the 6th. to the 10th. tapping days, an index of yielding capacity was obtained which was practically identical with that given by the complete records for the full period. It is proposed to continue the tests at intervals of six months until the trees are $5\frac{1}{2}$ years of age when regular tapping can be commenced. This work was initiated by Mr. L. E. Morris and has been continued since his departure on leave.

K. N. Kaimal

TABLE XIV. *Results of test tapping in a mixed planting of buddings and seedlings. Seedlings planted December 1926. Buddings made in the field September 1927. Test-tapping—May 1932*

Growth and Yield data	Seedlings	Clone A.V. 33	Clone A.V. 49	Clone A.V. 152	Clone S. R. 9	Clone K. 10	Clone H. 72	Unproved buddings of mixed clones.
Mean girth of trees in inches	—	16.9	20.2	20.7	18.4	18.0	18.7	—
Per cent, trees tappable	92	82	100	97	98	96	95	91
Total yield 5 tappings in ozs. (air dry rubber)	0.78	1.56	2.06	2.43	1.77	1.47	2.49	1.09
Actual yield in grms. dry rubber per tapping	3.9	7.8	10.3	12.2	8.8	7.3	12.5	5.4
Relative production	100	200	264	312	227	188	319	127

A test of the application of one of the methods of test-tapping described above was carried out on a mixed planting of buddings and seedlings on an outside estate. All trees, buddings and seedlings, having a girth of 14 inches or more at a height of 20 inches, were tapped alternate daily with a half circumference, spiral cut at a height of 20 inches. Yields from the first five tappings were neglected; for the next five tapping days, latex was coagulated in the cups and the samples of rubber retained on hooks attached to the trees.

When air dry, the samples were weighed in the field and the yield of each tree recorded. A summary of the analysis of the yield records is given in Table XIV.

It is intended to compare the results of these early tests with later yield records when the trees are brought into regular tapping. This experiment demonstrates the possible value of short period tests in the selection of valuable clones. The actual and relative yields of the buddings of the proved clones agree very well with their early, published records.

C. E. T. Mann & K. N. Kaimal

(5) COLLECTION AND TESTING OF SELECTED MATERIAL

(i) The collection of new clones, as these are established from time to time, is being continued. The collection now includes 38 clones developed in Java and Sumatra and 42 clones of Malayan origin. Of these, 55 clones are represented in small demonstration plots each containing 20 trees; the remainder have been used in large scale field experiments.

(ii) During the current year two experimental blocks, each of 10 acres, have been planted with seedlings grown from 'clonal' seed i.e. seed collected from budded trees of well-known, tested clones.

(iii) In December 1932 seed from budded trees in an isolated seed garden containing clone A.V.R.O.S 157 and a number of other proved clones was received. The value of this material in comparison with buddings of proved clones will be investigated.

C. C. T. Sharp & C. E. T. Mann

IV. Ecological Studies.

(i) The wide interest which has been aroused in forestry methods of rubber cultivation has entailed a considerable amount of systematic botanical work. Numerous collections have been made on estates on various soil types and a collection of the majority of plants which appear to be desirable members of a mixed, natural cover has been prepared and is available for reference. Much of this work has been carried out in collaboration with the Soils Division.

(ii) A detailed ecological study of the stages of regeneration of the natural flora on a washed hill soil planted with rubber, has been commenced in the Lake Gardens experimental area.

K. N. Kaimal

V. Field Experiments on the R.R.I. Experiment Station at Sungei Buloh.

Block Number	Acreage	Description of Experiments in Progress.	Date of Commencement
1	2½	Growth of buddings in the Multiplication nursery	Nov. 1929
2	30	Museum block. Study of seedlings of known origin from Ceylon, Java & Malaya.	Oct. 1928
		Test-tapping experiments.	Jan. 1932
		Interplanting with budded trees of vigorous clones.	Dec. 1932
3	8	Study of clones developed from legitimate seedlings from the 1928 crosses of Pilmoor clones.	Nov. 1930
4A	5	Legitimate seedlings and controls. 1928 crosses.	
	5	Clonal seedlings.	Dec. 1928
4B	5	General nursery for propagation and study of budded material.	Oct. 1928

Block Number	Acreage	Description of Experiments in Progress	Date of Commencement
4C	2½	Stock and scion experiments with twin seedlings	Dec. 1929
4D	2½	Comparison of methods of planting seed at stake, basket and stump planting.	Nov. 1928
		Test-tapping experiments. Provision of material for the study of bark renewal.	Dec 1931
5	40	Clone Trial Experiment. Comparison of growth, development and performance of buddings of proved clones. A.V.R.O.S. clones 49, 50 and 152. Prang Besar clones 23 and 186. Tjirandji clone 1. Bodjong Datar clone 5. Pilmoor clones A. 44 and B. 84.	Nov. 1929
10	10	Study of influence of scion on stock. Budding on stocks 2¾ yrs. of age. Treatment of the union in budding operations.	Oct. 1931
14 A & B	40	Study of clones established from legitimate seedlings from crosses made in 1929, 1930 and 1931 between the best Pilmoor clones and (in 1931) clone Glenshiel 1. Treatment of pruning cuts at union of stock and scion.	Oct. 1931 Aug. 1932
14 C & D	40	Influence of planting distance on growth development and performance of budded trees. Six densities of planting. (Latin square with 6 replications.)	Dec. 1930

Block Number	Acreage	Description of Experiment in Progress	Date of Commencement
14 E	10	(i) Study of seedlings selected by the Cramer nursery test method.	Dec. 1931
		(ii) Influence of stock on scion.	Dec. 1932
	9	Legitimate seedlings from 1931 crosses.	Oct. 1931
		Seedlings from isolated seed gardens.	Apr. 1932
15	83	(i) Study of new clones established from mother trees selected on Malayan estates. Budding in the field commenced:—	Nov. 1931
		(ii) Collection and study of tested clones from all sources. Budding in the field commenced:—	Nov. 1931
16	35	(i) Study of variation in families of seedlings derived from single high yielding trees.	Oct. 1929
		(ii) Legitimate seedlings from crosses made in 1929 between the best Pilmoor clones.	Oct. 1929 Feb. 1930
17 A	10	(i) Study of buddings and seedlings in mixed planting with clones. AVROS. clones 50, 183 & 185, Tjirandji clones 1 & 16, Glenshiel clone 1.	Dec. 1930
17D	8	(ii) As in (i) but with clones Rub. 393 and Sab. 24 in place of AVROS. 183 and 185.	May 1931
17C	10	(iii) Duo-clone planting with clones D. 65 and AVROS. 50.	Oct. 1931

Block Number	Acreage	Description of Experiments in Progress	Date of Commencement
17D	10	(iv) Study of the value of clonal seed as commercial planting material.	Nov. 1932
19	53	Monoclone planting with clone B.D. 5. Budded in the field:—	Dec. 1930
21	25	Polyclone planting with clones AVROS. 50, 71 and 256. Tjirandji 16. Bodjong Datar 10, Sungei Reko 9, Ct. 88	Oct. 1931
22	10	(i) Polyclone planting with clones AVROS. 49 and 152, Tjirandji 1, P. B. 186 and Rubana 393.	Dec. 1932
	10	(ii) Stock and scion experiments with twin seedlings made from clonal seed. Planted:—	Nov. 1930 Nov. 1932
24	33	Monoclone planting with clone B. D. 5. Budded in the field.	Dec. 1930
25	45	(i) Legitimate seedlings from 1930 crosses of Pilmoor clones.	Oct. 1930
		(ii) Buddings from 1928 crosses of Pilmoor clones.	Jan. 1931
		(iii) Twin seedlings from clonal seed of clone P. B. 24.	Nov. 1932
		(iv) Study of seedling families derived from high yielding mother trees and proved clones.	Dec. 1931
Jungle Plot A.	5	Seed garden of <i>Hevea spruceana</i> for stock experiments. Budded in:—	Dec. 1932
Jungle Plot B.	5	Seed garden of <i>Hevea spruceana</i> and <i>Hevea brasiliensis</i> . Budded in:—	Dec. 1932

VI. Advisory Work.

(1) CORRESPONDENCE

Despite the extremely difficult conditions which existed throughout the year, conditions that have made it necessary to consider very closely every item of expenditure on estates, the volume of advisory work dealt with by the Division has been maintained. In the nature of this work there has been a very important change. Comparing the subjects of the written enquiries dealt with in 1931 and 1932 interesting differences are revealed. In both years, some 1200 enquiries were dealt with; in 1931, 700 of these dealt with work on budding and 91 concerned tapping problems. In 1932 the corresponding figures were 468 and 340. Interest in special tapping methods, designed to effect economies in cost of production, is no doubt responsible for this change in the nature of our advisory work. Incidentally, the figures quoted may be taken as a useful indication of the lines along which further research should be vigorously prosecuted. A detailed analysis of advisory correspondence is given in an appendix to the Director's report.

Collaboration with estates in the conduct of tapping experiments has been a feature in the development of our work during the year. This again must be regarded as a most important development, for it is a certain indication of the need for reliable information on tapping problems that estate managers, with their much depleted staffs, are willing to undertake the considerable extra work involved in the conduct of experimental work. In the brief analysis of advisory activities given below it will be noted that no less than 26 estates have consulted the Institute on the conduct of tapping experiments and from the majority of these, regular returns of experimental records are received for analysis and comment.

Though the volume of advisory work on budding has fallen during the year it still remains the most important subject of enquiry. It would appear that, even though rigid economy is necessary, estates are not neglecting their developing budded areas. Experiments on the tapping of budded trees are in progress on 33 estates and to the majority of these regular visits are paid.

There has been a noteworthy increase in the number of enquiries on general planting practice and the majority of these concern the identification of plants and

comments on their suitability in the work of regeneration of poor areas.

<i>Subject</i>	<i>Branch</i>	<i>Total no. of Estates, Agency Houses or individuals seeking advice</i>	
Budding	General Enquiries.	...	454
Tapping	Mature seedling trees	...	155
	Experiments on tapping of mature seedling rubber	...	26
	Tapping experiments on Budded Trees	...	33
Selection	Selection of Mother Trees	...	100
	Seed Selection.	...	6
	Isolated Seed Gardens	...	16
General	Planting Enquiries	...	90

(2) ESTATE VISITS

Visits to estates, where the subject of enquiry could not be dealt with satisfactorily by letter, have been made whenever possible, but the reduction of staff and the increasing amount of time required on the Experiment Station in the conduct of research investigations has made it necessary to reduce the amount of estate visiting work. The summary of visits is given below.

	<i>Visits to estates on advisory work</i>		<i>Visits paid in connection with research work</i>
Mr. C. E. T. Mann	...	72	39
Mr. C. C. T. Sharp	...	12	78
Mr. K. N. Kaimal	...	1	83
		85	200

(3) INTERVIEWS

Visitors to the Division totalled 85, 24 of whom came to discuss tapping problems, 36 budding questions, 1 seed selection, and 24 discussed general planting subjects.

(4) EXHIBITIONS

An exhibit was prepared and staged at the Annual Exhibition of the Malayan Agri-Horticultural Association held in Kuala Lumpur from July 30th to August 1st, 1932. Demonstrations of budding work and exhibits illustrating methods for the identification of

clones and the characters of various cover plants were arranged.

(5) LECTURES

Lectures on recent progress in budding work and the tapping of budded trees were given by Mr. C. E. T. Mann to:—

- (1) Kuala Selangor Branch of the Incorporated Society of Planters on April 27th. 1932.
- (2) Taiping Branch of the I.S.P. on April 29th. 1932.
- (3) Klang Branch of the I.S.P. on May 10th. 1932.
- (4) Nilai-Labu Branch of the I.S.P. on October 28th. 1932.
- (5) Tampin-Bahau Branch of the I.S.P. on December 15th. 1932.
- (6) At the Annual Conference of the I.S.P., held at Port Dickson on September 17th. a lecture on "The Physiology of Latex Production" was given by the Head of the Division.

VII. Publications

1. "Some Variations of budding technique on big stocks."
by C. C. T. Sharp.
Journal of the R.R.I. of Malaya Vol. 4 No.1
2. "Tapping—The Effect of Sunday Rest."
by B. J. Eaton and L. E. Morris.
Journal of the R.R.I. of Malaya Vol. 4 No. 1
3. "Budding of Rubber Trees in 1931."
by L. E. Morris.
Malayan Agric. Journal Vol. 20 No. 5.
4. "The Physiology of Latex Production."
by C. E. T. Mann.
The Planter Vol. 13 No. 4.
5. "Recent Developments in Budding Practice."
by C. E. T. Mann.
The Planter Vol. 13 No. 6.

C. E. T. MANN

Head of Botanical Division

ANNUAL REPORT

PATHOLOGICAL DIVISION

STAFF

Mr. A. Sharples continued his duties as Head of the Division until the departure for home leave of the Director when he took over those of Acting Director, while Dr. A. S. Corbet and Mr. F. Beeley who returned from home leave on 3rd February and 22nd April respectively were appointed joint Acting Heads of the Division. On the retrenchment of Dr. A. S. Corbet in August Mr. F. Beeley became sole Acting Head. Mr. R. P. N. Napper continued his services as Pathologist during the whole of the year.

Mr. Gunnery, Technician, left for home leave on the 30th August.

It will be seen that the Division has had a very broken year ; having no Asiatic graduate assistants, Mr. Napper and Mr. Beeley have been left to carry on the whole of the work of the Division.

We are indebted to the Asiatic junior staff for the valuable assistance they have given during this difficult year.

Research

The programme of work laid down at the beginning of the year has been followed as far as possible. In the earlier months of the year Mr. Sharples and Mr. Gunnery did much work on an investigation into the mechanism and physiology of attack of roots by various root disease fungi. Much interesting information, demonstrated by photomicrographs of sections, has been obtained and it is hoped that time will be available this year to assemble the data for publication.

TREATMENT OF PRUNED SURFACES OF LARGE BUDDED STOCKS

Further work by Mr. Gunnery consisted of an attempt to find a suitable cover for pruned surfaces of large stocks in budding. As a result of this a mixture of wax and sulphur was prepared which, in the early stage and providing efficient heavy shade was maintained, gave excellent results in promoting callus formation and healing over. It has however been found that this mixture is unsuitable for use in exposed situations, where the wax melts in the heat of the sun, runs down the stem and chokes or poisons the bark. During this work however, it was demonstrated that the slope of the cut was a feature of considerable importance, and that the final pruning cut should not be made at an angle of less than 45°. A more steeply sloping cut is not a disadvantage and

by utilising this information in conjunction with the Asphaltum-Kerosene mixture, improved results are being obtained.

HEVEA LEAF MILDEW—*Oidium Heveae*

Recent laboratory experiments combined with an analysis of the meteorological data of the various rubber growing districts of the East have resulted in important suggestions being made with reference to the Hevea Mildew problem in Malaya. It has been shown that the high temperatures and low humidities experienced during the midday period in the Malayan lowlands are quite unfavourable to an optimum activity and spread of the fungus. Heavy rains, while merely preventing the spread of fungus spores, are of value chiefly in promoting a more rapid refoliation of the trees, so that the leaves quickly attain maturity when they are no longer subject to attack.

Reduced temperatures, such as are found in the higher rubber lands of Ceylon, Sumatra and Java, are however less favourable to the growth of leaves, and more favourable to the growth of the fungus. Hence rubber trees growing at higher altitudes suffer from Leaf Mildew to a far greater extent than the lowland rubber in Malaya.

A full report of these investigations has been published together with a report on the sulphur dusting experiments carried out early in March and April, 1931 when some 1,200 acres of mature rubber were dusted at a cost ranging from \$1.86 to \$3.36 according to the weight of sulphur dust applied per acre—from 5 to 10 lbs. on each of five occasions throughout the refoliation period.

Sparsity of foliage, which was commonly observed in some districts during the latter half of the year, was in the most part due to the drought experienced in the middle of the year having caused a secondary wintering with only a partial refoliation. This secondary wintering, which was particularly noticeable on hilly land in the older estates, is a result of drought combined with unsuitable or inadequate cultivation from the point of view of soil and water conservation, and is not to be confused with the pathological symptoms of the mildew disease caused by *Oidium Heveae*.

ROOT DISEASES

Fomes lignosus.—Intensive study of the parasitism of this fungus was continued during the year under review, and the main conclusions to be drawn from the results obtained may be summarised as follows:—

- (a) The fungus gains entry into a host by direct penetration through living, healthy bark. No cases have been

observed of penetration through ordinary wounds. The fungus is very susceptible to competition and it is doubtful whether it can establish itself in tissue, either living or dead, which is already colonized by other organisms.

(b) It follows from (a) that the distribution of disease in a new clearing is governed entirely by the distribution of disease in the previous stand at the moment of felling, only those root systems infected before death being of any danger to the future stand.

(c) From (a) and (b) it follows that, if the latter distribution can be determined with accuracy either before, at the time of, or after felling, the development of disease can be prevented in the most economical manner, i.e., by a process of selective cultivation.

(d) The method of discovering the distribution of diseased material in the soil described in the *Journal of the Institute* (Vol. 4, No. 1), in which the rubber trees themselves are used as indicators, has been proved to be highly successful in large scale trials.

(e) The fungus migrates from one source of food supply to another by means of rhizomorphs. These structures are not produced until the rotting of the original source of food supply has reached a certain stage of development. This stage is probably attained when all the food reserves of the source have been converted into fungus tissue. The young rhizomorph system is nourished by the mass of mycelium packed in the skeleton of the original source, and continues to spread until the mass is exhausted of its food reserves. If by that time the rhizomorphs have not established contact with living roots the whole system dies, and it is no longer a potential source of infection.

(f) The rhizomorphs cannot spread to any appreciable extent directly through the soil, but require hard surfaces along which to travel. They expend a proportion of the food reserves of the mycelial mass in covering the surface of each obstacle they encounter, and the effective range of each centre of infection varies inversely with the concentration of obstacles in the soil. Thus the incidence of the disease will tend to increase when partial clearing of the mass of rotting timber in the soil is undertaken, but a limit of increase will be reached at the stage when further removal of buried timber will break up the continuity of obstacles which the fungus requires for its subterranean propagation, and will thus lessen the effective range of each

centre of infection, and reduce the incidence of infection as a whole. These arguments lend further support to the theory of the relation between the incidence of the disease and the amount of timber left in the soil by various systems of clearing, as discussed in the Journal of the Institute (Vol. 4, No. 1, pp. 14-16.)

(g) Fructifications of the fungus appear at all times of the year after periods of heavy rain. When fresh they are highly fertile but the spores are delicate structures and the extent to which they are able to withstand the rigours of normal wind distribution is not yet known. Field evidence suggests that the propagation of the disease by spore infection is of minor importance.

Ganoderma Pseudoferreum.—During the course of the investigations on *F. lignosus* several new facts have come to light in relation to the parasitism of *G. pseudoferreum* on the rubber tree. The more important conclusions which have been drawn from a consideration of these facts are summarized below :—

(h) There exists such a strong analogy between the modes of origin, propagation and attack of *G. pseudoferreum* and *F. lignosus* respectively in rubber plantations that all that has been written in paras (a), (b), (c), (d) and (e) above with regard to *F. lignosus* applies with equal force to both fungi.

(j) Like *F. Lignosus* the fungus spreads by means of a rhizomorph system, and penetration of living tissue takes place through healthy bark from the underside of the rhizomorphs. These structures are creamy white at first, but later harden at the surface into a very characteristic dark red skin, the colour of which changes to bright wine red when moistened. The red skin can readily be obtained in pure culture.

(k) The disease caused by the fungus is not confined to mature rubber areas but is generally distributed equally with that due to *F. lignosus* in stands of all ages. There is one important point of contrast, however, between the diseases caused by these two fungi. Whereas the actual numerical losses due to *F. lignosus* are high in young stands and low in mature stands, the reverse holds good for *G. pseudoferreum*. This dissimilarity can be traced to the interaction of two observed facts, viz. that the rhizomorphs of *G. pseudoferreum* are less robust and grow less rapidly than those of *F. lignosus*, and that tissue infected by the

former fungus does not rot away so quickly. The centres of infection of *G. pseudoferrugineum* are therefore fewer in number and less diffuse than those of *F. lignosus*, but remain active for a sufficient length of time to enable the fungus to attack the stand of rubber at a period when every facility is provided for rapid spread by root contact.

The practical importance of the discovery that *G. pseudoferrugineum* causes the death of seedling trees cannot be overestimated. It enables the centres of infection to be traced and removed before they have caused any visible damage and at a time when treatment of *F. lignosus* is in progress, so that both diseases can be controlled in one operation. The cost of treatment therefore becomes negligible compared with the cost of control in mature areas, and the treatment should prevent almost entirely that serious loss of valuable trees which is such an alarming feature of many of the older plantations at the present day.

Sphaerostilbe Repens.—Towards the end of the year during the wet season it became necessary to investigate several outbreaks of the disease known as Stinking Rot of Roots caused by *Sphaerostilbe repens* which had appeared in connection with white ant control. It would seem that the disease has been brought on by the wet weather and is predominant in the flat peaty soils having a heavy clay subsoil difficult of drainage. Buried infected timber is the usual source of infection of the rubber roots. Flooding of such susceptible areas for the purpose of drowning out the termites, which also like the same swamp type of soil, should be avoided. It is of interest to note here the association of a *Nectria* sp. and bacteria with a similar foul smelling rot of the roots of young trees, dying as a result of termite attack.

PANEL DISEASES

Mouldy Rot.—During the year several disinfectant fluids have been tested for use in control of *Mouldy Rot* and two have shown considerable promise. Further work is required to decide the question as to whether it is better to use a comparatively expensive water-proof fungicide such as Cargilineum applied at intervals of several days or to use the cheaper water-miscible fluids applied every tapping day, but it is bound to be dependent on prices of materials, costs of labour, and duration of prophylactic effect of each treatment.

An investigation into an outbreak of Mouldy Rot in the Negri Sembilan and North Johore districts during September lead to the following conclusions.

1. The time of day during which rain falls is of great importance. Light rain during the normally dry midday period makes conditions more favourable to the disease.

2. The topographical situation of an area may be such as to cause late morning mists and absence of breezes. Such conditions favour the spread of the disease.

3. The tendency to allow weeds and tall heavy leaf belukar and rubber seedlings to come in produces damp conditions favourable to rapid growth of the fungus.

4. High ground is usually drier and free from disease.

5. Thick seedling belukar allowed to grow up in ravines prevents aeration, and nearby diseased trees may fail to respond to treatment.

6. The early afternoon rains also have the disadvantage of diluting or even washing off the fungicides which may have been applied when lifting the latex.

INSECT AND ANIMAL PESTS

Cockchafer grub pest.—This pest has now been reported as damaging rubber in three localities in Perak, Selangor and Negri Sembilan. The pest seems to spread from neighbouring jungle areas where it is normally kept in check by natural enemies, either other insects or animals such as the wild pig, which will eat either the grub or beetle. In the conditions of a rubber plantation however the natural enemies are not so numerous and the rate of spread of the pest increases considerably and some economic method of control must be found. At the present prices the use of the usual soil insecticides is prohibitive.

The beetle (*Psilopholis Grandis*) has a complete life cycle period of about one year. During the early months of the year eggs are deposited 6 to 12 inches deep in the soil.

They are usually deposited in clusters of about 34. These hatch out to give the larvae or grubs which then burrow through the soil and feed on the roots of plants with which they may come into contact. Young rubber roots are also attacked, and one estate reports that young trees planted out as stumps have been repeatedly attacked by this pest.

Mr. G. H. Corbett, Entomologist to the Department of Agriculture reports on this pest as follows:—

“Available evidence indicates that the spread has not been extensive and that yield of latex has not dropped. In the meantime, in order to lessen the damage, if any, to the roots of healthy mature rubber, alternative food in the nature of the roots of young seedling rubber and wild plants should be supplied. It is particularly important, however, that plants other than seedling rubber should not be standing when the beetles commence to emerge as spread will thereby be encouraged.”

"The movements of the grubs towards diseased rubber roots would appear to be associated with frequent changkolling of the soil and, in the present state of our knowledge, the collection of grubs from the soil should be avoided."

"Two Scoliid wasps, *Campsomeris tristes* and *C. pulchrivestita* "predaceous on the grubs of the beetle, and a hyperparasite, a "Bombyliid fly *Exosprosopa* sp. predaceous on the grubs of the "wasps, have been discovered."

Termites or White Ants.—During the first half of the year Dr. A. S. Corbet investigated the mode of attack of termites on young trees on the Experiment Station.

In all cases the termites attacking these (3 year old) trees were identified as *Coptotermes curvignathus* Holmgr. Only in a few cases was any sign of root disease found in the trees suffering from termite attack which is of interest in that *C. curvignathus* has been recorded previously as causing damage to living rubber trees but it is often tacitly assumed that such attacks occur only on diseased trees.

Other species of termites were also found on jungle timber in the same areas, but these did not appear to attack the rubber trees.

A form of treatment with insecticide powder was developed, the chief insecticide used being Paris Green, which was lightly dusted from a hand dust-gun on to the tap root and as high up the trees as the termites had worked. Before dusting it is essential to remove from the trees all earth and debris used by the termites to protect them from other insects and birds. This method of treatment proved entirely successful on the Experiment Station and on many estates.

Other insecticides as dusts or liquids are undergoing trials, while the use of rubber jellies formed by absorption of certain insecticides by dry raw rubber is also being tried out.

GENERAL REMARKS ON DISEASES

During the year there has been no outstanding epidemic over the whole country. Certain localities have however suffered rather heavy attacks of certain diseases. The West coastal districts of Malacca, Negri Sembilan and Perak had a comparatively heavy attack of leaf Mildew caused by the fungus *Oidium Heveae*, while the remainder of the country suffered practically none at all, though it was observed that the inflorescences of the trees in Selangor were heavily infected with the fungus until about the middle of the year.

Mouldy Rot also has been very prevalent in Negri Sembilan, Central and North Johore. Owing to the low price of the commodity small holders cannot afford to control the disease in their plantations so that neighbouring estates who have tried to combat the

disease have found infection reappearing as soon as treatment was stopped. The general tendency to allow areas to revert to "Forestry" conditions also renders supervision and control of this disease very difficult.

Several enquiries were received from managers to the effect that they had found a kind of Mouldy Rot of the upper cut in areas where a double cut system of tapping had been adopted. An inspection of several such estates revealed that the upper cut had gone dry and about two inches of the renewing bark above had died. The dry rubber content of the latex had in those weeks dwindled from about 40 to 20 per cent. since the commencement of the alternate monthly double cut daily system of tapping. It was finally concluded that the drying up of the cuts and death of the bark above was a physiological reaction following over drastic tapping. Recovery has since taken place on reversion to a more conservative system of tapping.

PINK DISEASE

This disease has not been troublesome this season but has been confined chiefly to the districts of heavy rainfall—South Kedah and the Eastern hilly districts of Perak, Selangor and Negri Sembilan. It has been somewhat troublesome in clearings of young rubber where treatment must be given at once otherwise the tree is completely ringed and must be pollarded.

MITES AND GLOEOSPORIUM

Mites in association with the fungus *Gloeosporium* sp. still cause a fair amount of trouble in nurseries and young rubber clearings. Observation indicated that soil and water factors largely influence this disease. Drought aggravates the symptoms considerably, especially on trees growing in soils having a hard gravel or sandy subsoil.

ROOT DISEASES

Root diseases still continue to receive attention most particularly in the nature of a systematic tree to tree inspection of clearings of young rubber and in the eradication of disease from areas of old diseased rubber which it is desired to replant.

PATHOLOGY OF RUBBER UNDER "FOREST" CONDITIONS

On visiting estates for various purposes we are frequently asked our views on the disease problem in areas where natural covers are allowed to come in. Briefly our views are that with tall seedling belukar as a cover there is great danger of Mouldy Rot, Black

Stripe and Pink Disease becoming very virulent. Hence in wet districts such covers should, from the disease point of view, be kept slashed while the tapped trees should be ringed or strip weeded. Lowlying land and ravines should be kept in low covers only, if panel diseases are to be avoided.

The question of alternative hosts among these natural covers is of some importance but will take many years of research and experiment to determine. Hence the need to avoid the encouragement of environmental conditions likely to favour the development of such fungi as the *Phytophthoras* causing Black Stripe and Patch or Claret Canker, of the *Corticium* causing Pink Disease, the *Sphaeronema* causing Mouldy Rot and the *Marasmius* and *Collybia* species associated with the Thread Blights, all of which thrive best under the damp humid conditions such as obtain in secondary jungle.

There is no direct proof that "Forestry" conditions favour the spread of root disease, in fact to date there is evidence to show that root disease spreads more slowly under covers. When systematic treatment of younger clearings is being carried out plants susceptible to these diseases serve to indicate disease areas and to locate buried infected timber so that in the early stages of growth it may be possible completely to eradicate such root diseases.

The success of Forestry methods will therefore vary greatly according to many factors chief among which are locality, rainfall, soil and attention and supervision given to the work.

PUBLICATIONS

The following articles were published during the year :—

- (a) Root Disease caused by *Fomes Lignosus*—R. P. N. Napper, Journal. Vol. 4, No. 1.
- (b) A Scheme of Treatment for the Control of *Fomes Lignosus* in young Rubber Areas—R. P. N. Napper, Journal. Vol. 4, No. 1.
- (c) Effects of Meteorological Factors on the Virulence of *Oidium Heveae* in Malaya.—F. Beeley, Journal. Vol. 4, No. 2.
- (d) Report on Sulphur Dusting Experiments—F. Beeley, Journal. Vol. 4, No. 2.

Correspondence and Routine Investigations

An analysis of the principal enquiries received and routine examination of material received is given as an appendix to the report of the Director.

A. SHARPLES

Head of Pathological Division

ANNUAL REPORT

CHEMICAL DIVISION

STAFF

During the year there have been various changes which are set out below:—

- Dr. E. Rhodes returned from leave and re-assumed duty on the 7th February.
- Dr. R. G. Fullerton resigned from the service of the Institute with effect from the 1st August.
- Mr. R. O. Bishop proceeded on long leave on 1st October, when Dr. Rhodes was appointed Acting Head of the Division.

During the last quarter of the year therefore only two officers instead of four have been available for duty and, while it is true to say that routine advisory activities have been effectively maintained, the reduction in personnel has not been without effect upon the progress of research.

INVESTIGATIONS OF LATEX CONSTITUENTS

(a) *Quebrachitol*

Considerable amounts of this material have been prepared for distribution to interested investigators, with the object of establishing an outlet for this possible by-product. An article has been published in which an estimate is made of its probable cost of manufacture on a commercial scale.

Contact has been established with and material supplied to a large number of investigators and organisations. In this connection we are indebted to B. D. Porritt Esq., M.Sc., F.I.C., F.R.S.E., Director, Research Association of British Rubber Manufacturers and to Dr. E. de B. Barnett of the Sir John Cass Technical Institute, London, through whose kindly offices many of these contacts have been made. Reports are not yet available from most of the interested parties, but we are now in possession of the findings of the Medical Research Council in a report by Drs. McCance and Laurence of King's College Hospital, London. It was hoped that the substance might prove of value as a food substance in cases of diabetes, but the investigators have established that, although quebrachitol does not act as a harmful sugar from the diabetic point of view, its use is precluded by the fact that it invariably produces either colic or diarrhoea.

An encouraging enquiry has however been received from an American organisation largely interested in the manufacture of

explosives, and information was sought as to the possibility of obtaining the material "in commercial quantities." It is possible that there is here, the making of at any rate, one outlet for this waste material; the company has been asked to indicate the extent of its commercial requirements and the price which it is prepared to pay for quebrachitol in various degrees of purity. If replies are favourable the Institute will bring the fact to the notice of the Industry.

(b) *Hevea Lipin*

A note published in the Journal has indicated that there is no possibility that this substance will prove of value as an ingredient of horticultural spray liquids. The note contains however some observations which are of considerable academic interest to those interested in the study of emulsion phenomena.

Samples of crumb rubber prepared from crepe rubber by the addition of Hevea lipin and subsequent rolling were exhibited at the M.A.H.A. Show in August 1932, but the material tends to mass in storage and is therefore not ideal.

(c) *Proteins and Amino Acids*

Latex proteins were obtained from the serum from creaming experiments, by saturation with ammonium sulphate. Hydrolysis of the proteins so obtained did not give evidence of the presence of sugars such as would be consistent with their supposed constitution as gluco-proteins. It will be necessary however for further experiments to be made before the definite assertion can be made that the latex protein molecule does not contain associated sugars.

Acid hydrolysates of latex protein were separated into the various amino acid groups by the butyl alcohol method of Dakin. Workable quantities of the mono-amino acids have been obtained in a clean condition, but have not so far been separated into their individual amino acids. Qualitative tests on the mixed mono-amino acids have indicated the probable presence of leucine as the major constituent. A small amount of tyrosine was also obtained in a crystalline condition. The diamino acid group when subjected to preliminary examination indicated the probable presence of arginine and lysine.

(d) *Progress towards the separation of unknown constituents of acid serum*

The separation of unknown soluble constituents from latex is continually hampered by the presence of quebrachitol which is extremely soluble and for which there is no known precipitant.

Its complete removal by crystallization is practically impossible and it continually makes its appearance in fractions, thought to be free. It has been found that, after removal of as much quebrachitol as possible, by direct crystallization, further amounts can be removed by continuous extraction with butyl alcohol, together with considerable amounts of soluble phosphates. This process is long and tedious; serum liquids have been extracted for 400 hours in order to free them from attendant quebrachitol leaving a material upon which to work with comparative freedom from its presence. Although tedious, such a course is being pursued and stocks of material almost free from quebrachitol are being slowly accumulated. Preliminary examination of some of this material indicates the presence of the diamino acids arginine and lysine, which is not surprising in view of their presence in the protein hydrolysates referred to above and in view of the fact that evaporated serum residues are almost bound to contain the products of protein degradation. Other bodies so far not identified form a large part of the quebrachitol free material.

(e) *Dialysable Constituents of latex*

Stocks of several hundred grammes of material have been obtained by the routine dialysis of perfectly fresh unpreserved latex at a low temperature in a cold chamber. So far we have obtained completely negative results when attempting to demonstrate the presence of the free reducing sugars which are popularly assumed to be present. Their presence has only been indicated after acid hydrolysis and our evidence so far points to the presence of the more complex sugars rather than the simple monosaccharides.

The examination of dialysate evaporated under reduced pressure has indicated the presence of amino acids and of leucine in particular. This was an unexpected observation since the time for proteolytic decomposition between tapping and the commencement of dialysis, is not more than two hours and the low temperature at which dialysis takes place would be expected to reduce further chemical decomposition to a minimum. Whether the amino acids present, really represent the degradation products of elaborated protein, or whether they are present in the latex at the moment of tapping and represent the raw material for protein synthesis, it is impossible for us yet to say.

LATEX PRESERVATION AND CONCENTRATION

(a) *Normal preserved latex*

The year has seen a very great stimulation of interest in latex preservation and shipment. The increased demand has

proved very welcome to the industry although it found the industry rather unprepared, in the sense that a large proportion of estate managers had had little experience of this class of work and further in that the ideal container had not been devised; if it exists at the moment, it is certainly not available to the planting public. The demand for advice has been adequately met and a manual on the subject of latex preservation and shipment has been issued during the year. Its contents are based upon a large number of observations and experiments made at the Institute and it is intended to help those who by reason of remoteness from headquarters are unable to take advantage of the personal demonstration and tuition, which has been freely given and which has helped to bring the laboratory technique of dry rubber content and preservative determinations to a number of estates. The manual was published in the light of local conditions to serve an immediate need. It therefore, for instance, merely indicates faults in the present methods of packing; to have attempted at the time to place a ban thereon would have been virtually to have attempted to prevent the export of preserved latex, since these methods of packing were and unfortunately still are, the only methods available. It is now evident that the demand for preserved latex will continue and it is also evident that very soon, latex of bad colour and quality and shewing lack of uniformity, shipped in unsuitable containers, will not be welcomed by the market. The producer of latex must prepare himself for more exacting requirements in the near future. Experiments have indicated that much undesirable material can be readily removed from latex by suitable mechanical treatment with consequent improvement in the quality of the product and it is probable that the Institute's associated committees for research in England, will be able materially to assist in the development of suitable containers which are unattacked by the preservative and the latex constituents. It is hoped by these and other means to assist all producers to retain and expand their present markets, with satisfaction to producer and consumer alike.

(b) *Concentrated Latex*

Interest in this commodity has again shown a very decided increase. Certain producers have made experimental shipments of concentrate prepared by the method of creaming described in the Manual on latex preservation and it is only because of the extremely delicate position with regard to existing patents that creamed latex has not already begun to establish itself as an article of commerce. It was with the knowledge that few producers could afford to be involved in litigation that the Institute, with

great reluctance, issued a warning that the export of creamed latex might involve exporters in difficulties. Experiments on the subject of creaming have progressed considerably and it is only the fact of the unfortunate patent position which has prevented the publication and recommendation of a modified method recently developed at the Institute. Samples of creamed latex prepared by various methods have been forwarded to London for examination and reports will become available in due course. The creaming agent which has been commonly used in our experiments is gum tragacanth and it has been demonstrated that the variable results obtained by its use are often in great measure due to the gum tragacanth itself. This gum is a natural product sold in very ill-defined grades and qualities—many of which are entirely unsuitable for creaming purposes. Of the many samples which we have been able to examine, the flake varieties have in general proved to be more satisfactory than the powdered forms, though there are many powdered grades which are very effective but usually costly. It has been observed that samples having high ash contents nearly always result in poor creaming of latex as do samples which produce solutions of low viscosity. Certain mineral substances, when added in quite small amounts, produce a definite retardation in the rate and degree of creaming and there is some evidence to show that latex from certain districts of Malaya tends to cream with greater ease than that from other districts; whether or not these facts can be correlated remains to be seen.

It has been possible during the year to make experiments with two different types of centrifugal machines, neither of which are at present employed for the concentration of latex on a commercial scale. With one of these machines, results were obtained which were very encouraging, though the output of concentrate was lower than perhaps might have been anticipated. A centrifugal machine will shortly be installed at the Institute for experimental purposes.

From the number of enquiries which have recently been received concerning the preparation of latex concentrates, it is certain that several producers would enter the field were it not for the various patents which hedge it round.

ALTERNATIVE COAGULANTS

The pressing need for economy in all branches of the plantation industry, led us to examine the question of cheap coagulants. The case for sulphuric acid was re-examined and the results of the work have been published in the Journal. In view of its condemnation as a result of the investigations carried out by Eaton and his colleagues at the Department of Agriculture and

the warning subsequently issued against its use in 1926 by the Rubber Growers' Association, the Institute has not attempted deliberately to advocate its use in preference to other accepted coagulants.

A substance which showed promise was ammonium bisulphate. It is a solid, and in theory at all events, it should be capable of production at a low price. By its use, good sheet was produced, but it was later found that the material is not marketed in quantity and such of it as was available was accordingly quoted at prices which were absurdly high.

MODIFIED RUBBERS

Work has been carried out with the object of producing from latex a rubber having properties different from those of normal sheet or crepe rubber.

By the simple expedient of coagulating in the second zone with a mineral acid, a rubber was produced which was apparently softer than normal. This was submitted to a local manufacturer who found that, although in fact soft, the rubber possessed bad ageing properties and for this reason was undesirable.

Other experiments have been made in which emulsified oils were introduced into latex prior to coagulation, but the results were not very encouraging.

Similarly substances such as cobalt oleate which normally accelerate the drying of oils, were prepared in situ in the latex before coagulation.

Further experiments in this field will be carried out.

VARIABILITY IN SHEET RUBBER

A note recently published on the subject of variability in sheet rubber prepared under laboratory conditions has indicated that, given careful control, in coagulation, machining and drying, the various sheets having within very small limits the same area, when dry, retain similar amounts of water after machining and draining, and show only small variations in tensile modulus.

CLONE RUBBER

During the year, a paper has been published in the Journal, giving the results of the early work on the variation in clone rubber from four clones on Pilmoor Estate. The criterion adopted was the tensile modulus at a given elongation and the rubber from each day's tapping was tested. The results cover the period July 1931—January 1932 inclusive and indicate that, as between

clones, the difference between monthly averages is small. Within each clone the daily variations are of the same order as those shown by rubber from a neighbouring stand of seedling trees. It is also shown that the daily differences in the rubber from any one clone are very largely reflected in those shown by the rubber from other clones: that on certain days the rubber from all clones would show a tendency towards a high modulus, and on other days towards a low modulus. These variations depend on factors external to the tree and are therefore largely beyond human control. The indication therefore is that even by the adoption of a rigidly standardised method of manufacture, it is not possible to guarantee that the rubber from one day's harvest will be identical with that produced on another day.

In the succeeding months from February, the practice of vulcanising daily samples has been discontinued. The whole of the rubber from any one clone for one month has been bulked and accurately sampled. The samples so obtained have been taken for test. The tests for the months February to September 1932 have indicated that in one month, the rubber from all the clones may have a high tensile modulus, and in another month a low tensile modulus. The exact reason is obscure, but it may transpire that the dominant factor is weather.

It has also been possible to compare the rubber obtained by tapping certain trees of each clone on a high cut, with that obtained by tapping other trees of the same clone on a low cut. Over a period of three months the vulcanisation properties of the rubber from low cuts, were not significantly different from those of rubber from high cuts.

The work is proceeding and in the coming year the tests will be extended to include ageing properties. It is also hoped that it will become possible to make systematic tests on rubber from clones which have been more largely adopted in recent plantation developments.

SHEET MANUFACTURE

(a) *Efficiency in machining*

Further studies have been made upon the efficiency of sheeting batteries and the factors responsible for variations therein. The observations have been made the subject of a paper in the Journal. It has for some time been generally realised that, when roll speeds were suitably increased and suitably harmonised, an increased output could be obtained; it was also realised that, in machining operations, a considerable amount of slip occurred on the smooth rolls; that the degree of slip is very variable and dependent upon

a number of factors has not been by any means such a matter of common knowledge and in the publication under reference the various factors which affect slip or efficiency have been disentangled and their effects translated into figures. In this way it has been possible properly to emphasize the advantage to be gained by machining a coagulum of the correct degree of softness and with correct roll settings. In handling rubber as a continuous sheet, these details assume considerable importance, since insufficient attention thereto may result in undue tearing of the coagulum and reduced output.

During the year a number of estates have been able to instal proprietary batteries capable of handling a continuous coagulum. In certain other cases, managers have with commendable skill, dismantled side by side batteries and re-erected them in column producing thereby continuous sheeters at a very low cost. In these cases the experience gained from our studies of efficiency problems has enabled us to be of some assistance.

Our attention has also been drawn to two forms of light portable and compact batteries, which have been developed by private enterprise. Both of these batteries will appeal to the small producer and one of them might prove to be suited to the requirements of Co-operative Society factories.

(b) *Smoke Drying*

It has not been possible to undertake actual experiments on smoke house design, but by the courtesy of various estate managers we have been able to collect information concerning different types of smoke houses which are giving satisfaction. In all cases however, the operations of smoking and drying are carried out simultaneously by hot smoke which has comparatively free access to the building and which therefore introduces some fire risk, although in some cases this risk is small. The Institute is alive to the situation and it is hoped that in the coming year definite progress will be made towards the introduction of still better types.

(c) *Air dried sheet*

Experiments have been continued with the object of producing a thin air-dried sheet of which the solution properties would be equal to those of thin pale crepe and which therefore might replace crepe in those operations in which solution properties are of importance. Extremely pale sheets having a thickness of approximately $1/12$ inch have been produced and tested and these give solutions of which the clarity approaches fairly nearly to that obtained with fine pale crepe. It is hoped that future work will advance the position further.

A few estates have been able to make contracts for air-dried sheet and there are signs that the market is beginning to take an interest in this grade of rubber. Since it demands for its preparation a type of drying chamber which introduces little or no fire risk, the acceptance of air-dried sheet as a standard market grade would be welcomed.

CREPE MANUFACTURE

Some preliminary experiments were made with the object of determining whether by handling a very soft coagulum and passing it initially through light sheeting rolls, it would be possible to avoid the use of certain units of the normal crepeing battery. The results obtained were encouraging, but the stage has not yet been reached where recommendations can be made.

RUBBER ROADWAYS

Research on this subject has been continued during the year and a separate report is presented describing the work.

RUBBER OIL

Samples of crude oil, of light fraction oil and of re-distilled light fraction oil were prepared at the request of Government and forwarded to the Rubber Growers' Association, London.

In view of the interest which has been shown in the possibility of the use of the light fraction oil as a motor spirit, the opportunity was taken to carry out some laboratory tests. These indicated that whereas the oil will undoubtedly operate a suitably adjusted engine, it nevertheless possesses certain disadvantages which, on continued use, might probably become apparent in bad carburettor action at low speeds, and cause also gumming of valves and dirty engines. These disadvantages would probably be less marked if the oil were employed for the operation of Diesel engines.

ADVISORY WORK AND ROUTINE CHEMICAL EXAMINATION OF ESTATE PRODUCTS AND MATERIALS

The analysis of correspondence and samples examined indicates that the advice of the division has been freely sought on all matters relating to the product and its manufacture.

The total number of letters and reports sent out during the year was 2792 as against 1685 in the year 1931, and, whereas in the previous year 1040 samples were submitted to us for examination, the total for 1932 is 3360.

The analysis indicates quite clearly that the increase in advisory activity was due in the main to the interest which has been taken in latex preservation and concentration.

So numerous were the latex samples received that their testing has caused great disturbance to the research work of the division. It was not until the situation had become very serious from the point of view of research that steps were taken to reduce the number of calls upon the professional services of the divisional officers.

Interest in factory machinery and equipment has been well maintained and press notices concerning patents for the preparation of rubber in powder form, have resulted in a number of enquiries.

A large number of hydrometers have passed through our hands and of these, a large proportion were new and of the same make and type. Our examination of these instruments has made it possible for us to make certain recommendations to the makers of this particular type of hydrometer and it is hoped that in the coming year the new shipments will be subject to a smaller error than has obtained in the past.

The desire to reduce factory costs has resulted in an increased number of enquiries concerning the use of cheaper coagulants. A few proprietary coagulants have been tested but none of these can be said to possess advantages over those in common use.

LECTURES AND DEMONSTRATIONS

Lectures were given during the year by the Head of the Division to planters' gatherings at Tampin, Malacca, Kajang and Kluang. In most cases the lectures were illustrated by cinematograph films on factory practice.

The Head of the Division also delivered lectures to the Singapore Rotary Club and at the Annual Conference of the Incorporated Society of Planters at Port Dickson.

Demonstrations on latex handling and sheet manufacture were given to officers of the Co-operative Societies Department, and a number of estate managers were given instruction on the laboratory technique involved in latex preservation and shipment, including the determination of "dry rubber" content and ammonia.

PUBLICATIONS

The various publications which have appeared during the year are as under:—

(a) *Papers*:—

1. Variation in Plantation Sheet Rubber, by R. O. Bishop and R. G. Fullerton. Journal. Vol. 3, No. 3.

2. The Effect of simple Carbohydrates on the Vulcanisation of Rubber, by R. O. Bishop and E. Rhodes. Journal. Vol. 3, No. 3.
3. Quebrachitol—a possible by-product from Latex, by E. Rhodes and J. L. Wiltshire. Journal. Vol. 3, No. 3.
4. Outbreaks of Fire in Smoke houses, by B. J. Eaton. Journal Vol. 3, No. 3.
5. Rubber roadways—A review by J. D. Hastings. Journal. Vol. 4, No. 1.
6. Further Notes on Sheeting Batteries, by R. O. Bishop and J. L. Wiltshire. Journal. Vol. 4, No. 2.
7. The Properties of Clone Rubber. Part I. by J. L. Wiltshire and R. G. Fullerton. Journal. Vol. 4, No. 2.
8. Sulphuric acid as a Latex Coagulant by J. L. Wiltshire and R. G. Fullerton. Journal. Vol. 4, No. 2.
9. Note on the Variability of Sheet prepared under laboratory conditions, by J. L. Wiltshire. Journal. Vol. 4 No. 2.
10. Notes on Quebrachitol and the Lipin of Hevea latex, by R. M. Woodman and E. Rhodes. Journal. Vol. 4, No. 2.

(b) *Manuals.*

Manual No. 3. "Plantation Sheet Rubber Manufacture" by R. O. Bishop.

Manual No. 4. "Latex Preservation and Shipment" by R. O. Bishop and R. G. Fullerton.

(c) *Information Cards:—*

Cards have been issued during the year, bringing the total to twenty-five; an index to this set has also been issued.

MALAYAN AGRI-HORTICULTURAL EXHIBITION

The various activities of the division were illustrated in its exhibit. The four sections of the stands showed,

- (a) latex in its various forms,
- (b) non rubber constituents of latex,
- (c) various grades of raw rubber and their method of preparation,
- (d) manufactured articles.

CORRESPONDENCE AND ROUTINE INVESTIGATIONS

An analysis of the correspondence and routine investigations is included in the appendix to the Director's Report.

EDGAR RHODES

Acting Head Chemical Division

ANNUAL REPORT

RUBBER ROADWAY INVESTIGATIONS

The research work on rubber roadway preparations made from latex, commenced in March 1931, has been continued throughout the year by Mr. J. D. Hastings working with Dr. E. Rhodes, the Executive officer, who returned from home leave in February. The progress of the work is best reported by using the same headings as were adopted in last year's report:—

- (a) Rubber road compositions made from latex.
- (b) The laboratory testing of such.
- (c) Rubber road compositions of public interest.

RUBBER ROAD COMPOSITIONS MADE FROM LATEX

It was previously pointed out that one of the first and biggest problems concerned with the use of a road material compounded from latex and laid as a paste, is the satisfactory removal of the water content. It is no longer difficult to compound stabilised latex with certain fillers, in quantities large in comparison with the rubber content, and so produce such a preparation, but the drying and hardening are slow; further the removal of the water contained in the paste by natural drying subsequent to laying is accompanied by cracking.

It may be that this cracking is not a serious objection to the use of such a preparation since the cracks can subsequently be filled, either with bitumen or some other surface dressing materials.

The general opinion of road engineers appears to agree that it is water penetration to the foundation that causes rapid disintegration of a road. If therefore a latex base preparation can be made which does not crack or need repair immediately after laying it seems more likely to prove satisfactory. Accordingly work has been largely directed towards a solution of this problem.

Early in 1931 when the work at the Institute was first started, many preparations were made by incorporating mineral powders and compounding latex with fillers. It was realised that a filler which would combine chemically with the water of the latex would be of great value in overcoming the cracking which is usually experienced. Fillers such as cement and Plaster of Paris were available and experiments with these materials were tried. At the time, it was found that our laboratory methods of compounding would not allow of their use. When used in large quantities coagulation could not be avoided, in spite of attempts to mix fillers into excessively stabilised latex. From information which Dr. Rhodes was able to gather

while on leave it appeared that other investigators had found the introduction of cement into latex a matter of some difficulty. On this account work with these dehydrating fillers was left until other lines had been tried.

Following the return of Dr. Rhodes from leave in February, experiments with pulp as a filler were started. In most of these paper pulp was used, which was obtained from old newspapers; a cheap and ready source. The latices were concentrates of dry rubber content varying from 45 to 55 per cent. prepared by creaming methods. Research on the concentration of latex by creaming has been proceeding in the Chemical Division and a constant supply of concentrate prepared by these methods has been available.

Some encouraging results were obtained by compounding creamed latex with fillers such as China clay together with pulp, using a small mechanical whisk stirrer and a Premier Paste Mill. Preparations were made which did not crack on drying when laid on the road; unfortunately the resulting products were not otherwise satisfactory. The drying-out of the paste resulted in a general contraction which weakened the anchorage at the edges of the pieces. However the results obtained by these methods of mixing suggested that the same procedure might be adopted to introduce cement. Preliminary experiments were promising; it was possible to introduce cement in larger quantities than before without coagulation and it appeared that the difficulties we had formerly experienced were due to methods of mixing.

The methods have been modified as experience was gained but the principle remains the same. By using a mechanical stirrer of the propeller type, with a speed sufficiently high to give a deep vortex in the latex, and by dusting the cement on to the edge of this vortex, so that it is drawn evenly into the liquid, we have been able to mix large quantities of cement into stabilised concentrated latex with a fair degree of uniformity. The speed of the stirrer, the shape of the propeller at the end of the stirring shaft, the depth of the vortex and the rate at which the cement is added all affect the ease with which it can be mixed and the homogeneity of the dispersion, more especially when the mix becomes viscous. It was soon evident that this line of work had possibilities and experiments have now been proceeding for some time; it seems fairly certain that, in the use of cement as a dehydrator, there is more hope of a successful rubber road preparation made from latex than in the use of any other form of filler.

Many different preparations were made on a laboratory scale embodying cement as a filler in large or small amounts which did not crack when laid and which on this account were promising. Those with a high cement content, when dry, exhibited few of the characteristics of rubber, being very hard but easily broken and had

a high permanent set, while those with low cement contents took a long time to harden even when using rapid hardening cements.

Our experiments with field latex and various types of cement have not been successful. We have not been able so far to produce promising preparations. The high water content of the latex necessitating the use of large amounts of cement for dehydration render the evolution of a rubbery material impossible. Some difficulty was experienced in mixing cements, other than the aluminous variety, into field latex with the vortex stirrer. Dispersion was not so good and large quantities of stabiliser were necessary. Better dispersion was found to be obtainable by adding a mineral filler such as China clay in small amounts previous to the addition of the cement.

With all the preparations cracking still occurred. As a result of these experiments which had not given any indication that, in the use of cement with field latex, any advantage except quicker drying could be got, we have confined our attention almost completely to creamed latex with which more promise was evident.

These results appeared to be sufficiently encouraging to attempt the mixing and laying of larger experimental patches than hitherto. We were able to obtain valuable assistance from the Survey Department and the Public Works Department engineers in the development of a larger mixing device. After some trials with this apparatus which worked satisfactorily, it was decided to lay a bigger trial area using a rapid hardening cement. An area of 50 square yards was laid for which the material was mixed in 12 batches. The result was at first satisfactory but severe cracking started. The material when dry was extremely hard. This experiment, although a failure, was of great value to the further work ; it showed clearly that the result of laying a small patch of material was no criterion of what might occur on a large scale. Our experimental plots had obviously been too small. The result again confirmed our conclusions concerning the use of large amounts of cement as a dehydrating filler that, with age, the material hardens considerably and tends to assume a cement-containing-rubber phase rather than a rubber-containing-cement phase.

At this stage of the work communications were received from England regarding the acceptance of patent specifications taken out by Messrs. Critchley & Bond for work on similar lines to those on which we had been working. It is evident from the date of the patent application that the investigations at home had been proceeding and satisfactory results achieved, before the work in Malaya was started in 1931. It was however very encouraging to find that the lines on which we had been independently working were very similar to those made the subject of the specification and of sufficient industrial importance to engage the attention of Rubber Roadways Ltd, who were trying the material,

Our results agreed in many respects with the conclusions of Critchley & Bond. There were however sufficient differences to cause us to continue our own along certain lines that shewed promise. It appeared that the material evolved by them was prepared from proprietary concentrated latices having dry rubber contents of approximately 70 per cent. and that a latex lower than 60 per cent. dry rubber content was not satisfactory. All our experiments were being made with a latex of lower dry rubber content, at first with field latex (D.R.C. 35-40 per cent.) afterwards with a creamed concentrate of average D.R.C. of 50 per cent. With a more concentrated latex the amount of cement necessary to combine with the water content is naturally less, hence the chances of a phase reversal, i.e. into a cement-containing-rubber phase, are less.

Our experiments with creamed latex and cement were encouraging, especially those with rapid hardening aluminous cements such as "Lightning" Cement and Ciment Fondu. We found that this type could be mixed into the latex with greater ease than any non-aluminous variety, and the amount of stabiliser necessary to secure the introduction of the required amount was considerably reduced. This was in agreement with the conclusions of Messrs. Critchley & Bond. We found however that it was not always possible to avoid cracking, more especially with mixes containing cement in proportions sufficiently high to dry out the material in a few days. When subjected to the normal direct heat of the sun after laying cracks seldom appeared, but when laid in the shade and then exposed splitting occurred. Further, unless the preparations were exposed to the heat of the sun, which caused surface coagulation, the material did not attain any coherence until dry, and the surface was easily broken by slight pressure.

It appeared that, if coagulation throughout the mix could be caused soon after laying, cracking might be prevented. Work on these lines was started using latex coagulants added just prior to the laying of the paste. Experiments with sodium silico fluoride were successful. When added as a powder in small proportions it was still possible to lay the paste before coagulation occurred. Cracking was entirely prevented. The action of the sodium silico fluoride causes a general coagulation throughout the paste. The quantity needed is dependent on the viscosity of the mix after the filler has been introduced. This can be varied with the amount of stabiliser used. Various stabilisers have been tried such as casein, gum tragacanth, sodium silicate, caustic alkalies and others. We found commercial sodium silicate extremely satisfactory; it is relatively cheap and we have used it throughout our experiments.

Further work on the same lines, using field latex instead of creamed latex was not successful. It has been possible to prepare from field latex mixes which did not crack when laid, but the amount

of sodium silicofluoride required was such that there does not seem much hope of using mixes of this type in practice. The action of the coagulant is difficult to control. The results of all our experiments indicate that the prospects of producing a satisfactory road preparation from field latex are small.

Experiments with different types of foundation have been made. A rough concrete, lightly marked before drying, proved very satisfactory, provided that the surface is free from sand and dirt. Preparations laid on this have held extremely well. A smooth rendered concrete also gave good anchorage, but was not so satisfactory as the rougher surfaces. When using a surface of this nature the laying of the material is much easier, a smaller amount of the mix is required and a smooth surface is more easily obtained.

The cement and creamed latex preparations have not so far been subjected to consolidation after laying. From sections cut from the material after laying, it is apparent however that the material has a very open texture. This may be due to the occlusion of air during the mixing process, to the presence of ammonia, or to the removal of water by the cement. Creams prepared with alkali other than ammonia have not been so satisfactory; moreover, they are more difficult to prepare. It is probable that the use of a roller before the paste is quite dry would consolidate and improve the texture without destroying the anchorage. Experiments on a small scale using a hydraulic press with a special frame are being undertaken.

Towards the end of the year experiments had reached the stage at which we considered we could attempt to lay some preparations on a larger practical scale. We again found that, with increase in size of mix, fresh problems were encountered. For example the amount of stabiliser required was found to be more than was expected. A mix of the right viscosity when made on a small scale was too viscous and sometimes coagulated when made on a large scale. It has already been mentioned that the rate at which the cement is fed into the mix affected the dispersion of the final paste, and it is also found that the time taken for the mixing process affects the results. A portion of the road at the Institute laboratory has been paved with some of our preparations. Approximately 150 square yards were laid across the road in sections of 14 feet by 6 feet, $\frac{1}{2}$ inch thick at the edges having a slight camber, to $\frac{3}{4}$ inch thickness in the middle of the road. Various methods of joining these bays have been tried, and we have been able to secure a satisfactory join by the use of the material itself. No difficulty was experienced with cracking. It appears however that abrasion is likely to be poor and that a material containing less filler will be more useful.

The problems concerned with the evolution of a suitable portable mixing apparatus are of great importance to the furtherance of larger trials of a similar nature. The mixer at present being used

is electrically driven and the cement is dusted by hand. The help of the P.W.D. engineers has been sought in the design of a portable mixer not dependent on electric power and having provision for the mechanical addition of the filler. Work on the production of such apparatus is in hand.

THE LABORATORY TESTING OF LATEX COMPOSITIONS

The position with regard to the testing of road compositions has advanced little. At present there is no real test other than that of service. Some experiments on the tensile properties of some of our cement preparations were tried, but we have not been able to evolve any technique which can be said to be of real use. The low percentage of rubber in the compositions and the uneven dispersion from a rubber testing point of view present great difficulty in the development of chemical tests. From observations made on the areas actually laid on the road at the Institute, an abrasion machine capable of testing small surface areas will be found useful. So far we have not been able to obtain such apparatus.

RUBBER ROAD COMPOSITIONS OF PUBLIC INTEREST

At the end of 1931 some small experiments using latex-bitumen emulsions as a grout were laid on the Kuala Lumpur—Port Swettenham road. These have not proved to be an improvement on the use of bitumen or bituminous emulsions. No disintegration of the foundation has yet taken place but surface wear has been more severe. A discussion on the subject of the relative importance of plasticity and resiliency in road grouting material was held with the acting State Engineer in which it was agreed that plasticity is of greater importance than resiliency. In our opinion this limits the use of rubber in the form of latex to proportions of the order of 10 per cent. in the grouting material. No further reports have been received of the experiments conducted by the Asiatic Petroleum Co. with latex bitumen emulsion mixes containing low proportions of rubber but advice received from England indicates that trials being made there are proving satisfactory.

The small trial strips of the "Silent Roadway" material of Messrs. Kendall & Graham laid on the Petaling side of the New Bridge, 6th mile Petaling road, appear to be wearing well. The P.W.D. engineer reports that some slight repairs were necessary as one of the pieces was coming loose, but this was not serious. Some surface oxidation resulting in minute cracks has appeared but wear is negligible. The result of a year's trial of this material seems to indicate that the problem is rather one of initial cost and satisfactory anchorage than of ability to stand up to abrasion under

traffic. Arrangements are being made for a large scale trial of the same material in Kuala Lumpur.

A demonstration by Mr. V. K. Singhan of his "Singatex" paving materials was given before His Excellency the High Commissioner F.M.S., at the Institute. From observations on the material then laid it is doubtful whether the various claims made for the product can be substantiated. A small area of a material "Singatexphalt" was also laid as a grout by Mr. Singhan in High Street, Kuala Lumpur. Surface wear is pronounced.

Several trial areas of a rubber roadway composition made from latex have been laid in Singapore and Penang by The Solar Rubber Processes Co., a company formed to market the Parry Davis-Cowling products. The practical tests will be watched with interest.

CONCLUSIONS

The result of the year's work confirms our opinion that the production of a really satisfactory rubber roadway material direct from latex is still a matter of difficulty.

The work with mixtures of cements and creamed latex has enabled us to produce promising non-cracking preparations, but it has indicated that a satisfactory roadway composition from field latex is still a matter of doubt.

A stage has now been reached at which little more can be done until the practical trial of some of these preparations indicate their possibilities under service conditions. This involves other lines of work concerned with the mixing apparatus, which are in hand.

The widespread use of a rubber roadway composition prepared on the lines indicated in these investigations will depend chiefly on the relative life of such a roadway in comparison with materials at present in use, such as asphalt and bitumen which are very cheap.

The life of such a roadway in respect of its behaviour under modern traffic and varying climatic conditions, especially strong sunlight and heat can only be determined by service trials.

Apart, however, from the general application of rubber to roadways, there is ample scope for its application on special sites, where, in particular, vibration effects in relation to foundation of buildings are of importance.

Important and useful applications which do not involve the problem of heavy traffic are pavements in towns and also railway platforms.

J. D. HASTINGS
Chemist

ANNUAL REPORT

LIBRARIAN

STAFF

At the beginning of 1932 the Library staff consisted of the Librarian, one clerk and one typist. Owing to retrenchment the services of the typist were dispensed with in July.

BOOKS AND PERIODICALS

The library is now well stocked with all the principal technical and scientific books and periodicals having a bearing on the work of the various Divisions of the Institute, in relation not only to rubber in particular but also to agricultural problems in general, botany, chemistry, plant pathology, soils, etc. It is now only necessary to add yearly the more important new scientific and technical books published, together with new editions.

An inventory of books and periodicals taken at the end of December 1932, shews a total of about 3,400 books and reports in book form and about 2,800 volumes of periodical journals. Of the latter 1,814 volumes are complete and have been bound. There are also about 1,200 miscellaneous bulletins, circulars and pamphlets.

During the year under review, 246 volumes of journals were bound and 40 new books were purchased. The subscription to journals was limited to 76 periodicals as against 114 the previous year.

EXCHANGES

144 Institutions and Official bodies are on the Library Exchange mailing lists and send copies of their publications in exchange for those published by the Institute.

DISTRIBUTION OF PUBLICATIONS

2,556 copies of each publication issued by the Institute were distributed free of charge to Rubber Plantations, Companies, Corporations, Institutions and to individuals whose names appear on the Institute's mailing list. In addition there are at present 190 subscribers, bringing the total issue of each publication to 2,746.

285 sets of Information cards were sent to applicants and the additional cards published during the year were forwarded to 1,496 subscribers to complete their sets,

PUBLICATIONS ISSUED IN 1932.

The following publications were printed and issued during the year :—

Journal	Vol. 3	No. 3	...	March
„	Vol. 4	No. 1	...	July
„	Vol. 4	No. 2	...	November
Annual Report	1931	...		May
Planting Manual	No. 3	...		February
„	„	No. 4	...	July

Information Cards—

Nos. 22C-24C and Index (25C) January-April.

INDEXING

Articles of interest, appearing in various publications, are indexed by the Librarian under authors and subjects and the records are kept on cards. 2,350 cards were typed during 1932. Most of the articles to be indexed are indicated by the Director and Heads of Divisions.

A new card system was introduced at the beginning of the year for the purpose of keeping a record of books and periodicals on loan. 6,294 cards were completed.

New books for keeping records of mailing lists of publications issued were started and are now up to date.

A number of translations were made mostly from Dutch, French and Italian publications.

A. McINERNY

Librarian

ANNUAL REPORT

EXPERIMENT STATION

During the year, the plan of the external survey, completed by the Revenue Survey Department was received, and the total acreage was shown as 2,096 acres.

The following details show the development of the area, at the end of 1932.

ACREAGE STATEMENT

Planted	...	795 acres.
Cleared not to be planted	...	11½ "
Elephant belt	...	96 "
Building site	...	68 "
Total opened area	...	970½ "
Jungle reserve	...	1,125½ "
TOTAL land under application	...	2,096 acres.

DISTRIBUTION OF LAND

Several areas, previously under the sole charge of the Pathological Division, have been taken over by Soils and Botanical Divisions. The Pathological Division supervises disease work over the whole area. The present distribution is as follows:—

Botanical Division	...	512 acres.
Pathological Division	...	28 "
Soils Division	...	255 "
Building site and elephant belt	...	164 "
TOTAL	...	959 acres.

CLEARING

No new clearing was done in 1932.

Forest Reserve Jungle Area.—The suitability of the reserve area is still under discussion. Two new areas, one further east than our present reserve and one on the western boundary of the Station, were inspected by Mr. Gardner and the Manager, and also by Dr. Haines. The eastern area presents certain difficulties, in that it would

necessitate the erection of coolie lines, water supply etc., and would have to have its own anti-malarial scheme.

The matter is at the moment in abeyance, till the Forest Officer, who has several experiments in the western area, returns, when it may be found possible to make arrangements to take over this area, which would be most convenient, and for which the present line accommodation and water supply would be sufficient.

LINING, HOLING AND PLANTING

Two areas only remained to be planted at the beginning of the year—Block 22, southern 10 acres, and 10 acres in Block 17, northern end. Block 13A (cover crop nursery of 5 acres) was planted up with basket plants.

The details of these areas are as follows:—

Block	Area.	Spacing	Holing	Cost per hole	Remarks.
17	10 ac.	11ft. x 11ft.	2ft. x 2ft.	1.4 cents.	Selected high yielding stumps and 300 seedlings. Adco fertiliser applied per alternate diagonal line of holes.
22	10 ac.	18ft. x 18ft.	2ft. x 2ft.	1.5 cents.	Twin seedlings and stumps.
13A	5 ac.	20ft. x 20ft.	2ft. x 2ft.	1.0 cent.	Basket plants

Supplying of disease patches has been done in the swamp area in Blocks 17 and 19 where *Fomes lignosus* was prevalent.

NURSERIES

Sulphur spraying for mites has been carried out whenever necessary.

Block 1.—In this nursery, which was divided into four plots, with two manure and control areas, the applications of Sterameal at first showed up to advantage over the Cresite and control plots. The difference now is negligible, and the area is being kept for supply purposes for 1933.

Block 4.—The budwood, from the 197 selected Malayan mother trees, budded in this nursery in 1931, is being used in Block 15.

Block 12.—Nursery is being selectively cut back, so that a type of Forestry Method of cultivation with cut-back plants acting as shade may be tried out. Observations on the 40 beds laid out with manures and controls having been completed, this area of the Block will also come under the above scheme.

Sungei Payong (Block 25).—This nursery, at the end of the year, when all supply material has been used, will be planted up 20 ft. × 20 ft. like the rest of Block 25 and come into the acreage of this Block.

BUDDING

Budding operations have been carried out in the following Blocks :—

Block	2	28 acres
..	14	15 "
..	15	25 "
..	18	78 "
..	22	10 "
Jungle Plot A		5 "

Supply budding, in originally budded Blocks, was also carried out.

Observations on results obtained and work in hand are published by the Botanical Division

MANURIAL TREATMENTS

Block 6.—The round of cattle manure and artificial fertilisers, which is now applied yearly, was started in December. Girth measurements were taken during the year, and the results were published by the Soils Division.

Block 17A.—Quarterly treatment with Cresite and magnesium sulphate was continued.

Block 17D. Northern 10 acres.—In this area, planted in November, one basket (about 1 gallon) of Adco fertiliser, prepared on the Station, was applied to each alternate diagonal line of holes over the northern 5 acres.

CATCH CROP EXPERIMENTS (Block 23)

Tapioca.—The tapioca on this area was again cropped in November/December. A total weight of 490 piculs (approximately 30 tons) was harvested, as against 396 piculs for 1931. The cost for two harvestings, which includes pulling, carrying of stems to jungle for destroying, removing tubers and replanting, are as follows for the 13 acres.

1931		1932	
Harvested	Total Cost	Harvested	Total Cost
396 piculs	\$150.00	490 piculs	\$88.31

Pineapples.—The pineapples are growing well and good crops are obtained. The pines are used for a manuring experiment, by the Soils Division.

Coffee.—During the year, a labourer was sent to Serdang Government Plantations for instruction in the upkeep of coffee. This crop is now doing well, and the leaf mite, from which it suffered so badly in 1931, seems, by repeated spraying with lead arsenate, to be well under control. Growth over most of the area is good.

ISOLATED SEED GARDENS IN JUNGLE

Two areas, of 5 acres each, which were planted in 1931, (planting distance 11ft. x 22ft.) and which have belukar left between the rows are making good growth.

Plot A, which is near the catchment area, on the southern side of the main road from Sungei Buloh, has been budded with *Hevea spruceana*.

In Plot B, alternate plants will be budded with *Hevea spruceana*.

It is hoped to obtain from Plot A pure seeds of *Hevea spruceana* and from Plot B hybrid seeds *Hevea spruceana* x *brasiliensis* for experimental work on the stock problem in budding practice.

DRAINAGE

Through the lowering of the two culverts on the main road through the Station, it was possible to concentrate on a definite drainage programme for the northern end of the Station. The existing main drain in Block 14 was deepened and resloped and 122 chains of intermediate drains 4 ft. x 1 ft. by 3 ft. deep were cut. A new drain 10 ft. x 1 ft. by 5 ft. deep was cut round the northern and western boundary of Block 23 which will benefit the rubber in this area. The drain, in the swampy area of Blocks 17, 18 and 19 has been cleaned out and a complete round of the anti-malarial treatment was carried out when necessary. Considerable trouble was experienced, due to silting up of the culvert at the southern end of the Sungei Payong in Block 18. Various methods of dealing with the situation were tried and finally it was decided to block up this culvert and allow the area to flood and silt up the depressions.

TERRACING, SILT PITTING AND BUNDING

During the year, no new work was done under this heading. The terraces on the hill, having stood up well despite heavy rains, needed only an occasional visit from the patrol to repair small slips.

Contour bunds in Blocks 15, 19 and 23 were repaired where necessary. The square bunds on the flat areas needed no attention, as the cover crop planted on these, when they were constructed, held them up very well.

COVER CROPS

In the fields where *Vigna* was planted, and where a noticeable die-back of this cover took place, supplying with *Centrosema*, *Calopogonium* and *Pueraria* has been most successful and weeding costs are down to normal again.

In Block 16, where the soil is very friable and covers are difficult to establish, the patches have been supplied with *Indigofera endecaphylla* and this cover is taking well.

In Blocks 20 and 21, in which there were one chain strips of bush, low covers and controls, the controls have been planted up with *Indigofera*.

This cover is the most successful low cover on the Station, and has the following advantages over *Centrosema* or *Pueraria*. It will grow in practically any soil, it has no thorns, does not climb or become high, and can be allowed to grow right up to the trees. It is leguminous and provides a good mulch, and can be planted very cheaply from cuttings. Supplies of this cover have been sent to estates all over the country and where it has been planted in new clearings and light shade, the reports of growth have been excellent.

Lantoro, (*Leucaena Glauca*) appears to be holding its own and, from observed results, seems to be the most suitable of the bush covers. As it provides a good leaf fall, the retardation of growth of the rubber trees seems to be much less than with *Crotalaria* or *Tephrosia*. *Fagraea racemosa*, a natural cover plant, is being looked for on the boundaries. A *Ficus* species similar to this plant which may prove useful, is being watched for seed which, if obtained, will be used in the "Forestry" Experiment.

SOIL WASH EXPERIMENT, WITH BUSH & LOW COVERS (Block 24)

The 3.6 acres which are divided into strips, running down the face of the hill in this block, are proving quite interesting. The erect growing covers were least effective, while the creeping covers protected the soil in proportion to their vigour of growth.

The covers planted are *Calopogonium*, *Pueraria*, *Indigofera*, *Crotalaria*, *Vigna*, *Centrosema*, *Tephrosia* and natural grasses. There is also a clean weeded strip, in which soil conservation is effected only by silt pits and bunds.

On each terrace and also between terraces, posts 5 feet long were buried to a depth of 2ft. 6ins. for purposes of measurement of soil erosion. Results of these measurements have been published by the Soils Division. (See R.R.I. Journal. Vol. 4 No. 2 p. 129).

CULTIVATION

Digging in of grasses and covers, in a circle about 9 ins. wide at 3 feet radius from the plants in Blocks 17 and 19 was continued

at alternate monthly intervals till October 1932. This work is now only done quarterly.

In Block 19, on the flat area above the swamp on the eastern boundary, 9 acres are being cultivated in the following manner. On three plots the grasses and weeds have been dug in and the area is now kept clean weeded ; on another three plots the grasses and weeds are dug in and allowed to regenerate and dug in again every 6 months ; the remaining three plots are left under grass and covers.

Growth measurements have been taken and results recorded by the Soils Division.

WEEDING

From January till October, the Station was on monthly weeding rounds. After consultation with the Acting Director a new scheme was tried.

The total area weeded is 809 acres. It was decided that 300 acres of this could stand two-monthly weeding employing podians each alternate month to keep the trees clear of any climbing covers.

For ten months till October, the average cost per acre for weeding was 32.6 cents ; from November the new rounds have averaged 24.6 cents. It is hoped that, once the wet season is over, a considerable reduction in the above figure will be experienced:

Eradication of lallang grass and slashing are being done by a small gang of women, and the cost for each is respectively 57 cents and 5 cents per acre.

PESTS & DISEASES

Damage by rats is now negligible. Grasshoppers are still attacking young plants and also the coffee, but are being held in check by spraying with lead arsenate.

Several cases of attack by termites have been noticed. The chemicals used in treatment are Perchloride of Mercury and Paris Green. The amount of Perchloride of Mercury used is 1 pint of a 2 per cent. solution per tree, and for Paris Green $\frac{1}{4}$ to $\frac{1}{2}$ oz. per tree, depending on the area attacked. Several other chemicals are being tried, but it is too early to make any definite statement as to the efficacy of treatment.

Dusting with sulphur, for attacks by mites in the nurseries, is carried out when necessary.

No elephants have been reported during the past year.

A few cases of "Pink Disease" have been noticed and these have been treated with a solution of Asphalt-kerosene and Brunolinum.

Cases of *Fomes lignosus* and *Ganoderma pseudoferreum* are showing up. These are specially dealt with by the Pathological Division, and their observations are being published. The method of treatment employed for dealing with fields suffering from attack by *Fomes lignosus* is as follows:—

A first round tree-to-tree inspection is made, and infected trees are dealt with in the following manner:—

The root system is exposed to the extremity of the diseased area; dead laterals are removed and live laterals which are attacked have the mycelium scraped off, and are washed with 1 to 1½ gallons of a 2 per cent. solution of copper sulphate. The source of infection, which is usually a standing stump or buried log, is traced and removed. The holes are then closed and affected trees are marked. In cases where the disease has progressed too far for treatment to be effective, the tree with all its roots is removed, and a hole 8 feet in diameter and 3 feet deep is dug around the site of the tree and all woody material is collected. The hole is then filled, and a further area of the soil up to 16ft. square is dug over a depth of 18 inches, and again all woody material is removed. An isolation trench 2 feet deep is cut round this area. The central, deeply dug area is drenched with 5 gallons of a 2 per cent. copper sulphate solution.

Further inspections are made at specific intervals and the above treatment is repeated.

First inspection of trees, without treatment, costs for young rubber an average of 20 cents per acre. For 3 to 4 year old rubber the cost is 30 to 40 cents per acre. In unstumped areas the cost of cutting patches, removing disease centres and applying copper sulphate is about 90 cents per patch including cost of materials. For disease areas where no stumping is necessary, the cost is 45 to 50 cents per patch.

The following Blocks were inspected:—

Monthly.—Block 9. *Alternate monthly.*—Blocks 7 and 8. *Three monthly.*—Blocks 4, 5, 15 and 16. *Four monthly.*—Block 21. *Five monthly.*—Blocks 2, 6 and 10. *Six monthly.*—Blocks 11, 13, 14, 17, 18, 19, 20 and 23.

Several cases of *Ganoderma pseudoferreum* have been discovered and treated as follows:—

The dead tissues are pruned away, and live roots, on which the coating of mycelium is found, are scraped and washed with a 2 per cent. copper sulphate solution.

Fomes lignosus, as previously mentioned, is excessive in the tapioca. This fungus has also caused the death of a certain number of coffee plants.

METEOROLOGICAL AND OTHER RECORDS

During the year the soil thermometers and wind gauge were removed to the Institute. A barograph, automatic rain gauge and sunshine recorder are in use on the Station, and records are submitted for examination to the Soils Division.

Height and girth measurements are taken at intervals and observations returned to the various Divisions.

RAINFALL

The rainfall for the year was 107.27 inches. (For monthly records see Annual Report of Soils Division).

ROADS AND BRIDGES

No new work was done under this heading.

Upkeep, which consists in weeding and trimming the sides of roads, costs 6 cents per chain.

The hill road in Block 19 and 24 is standing up well this year.

Reinforced concrete foot bridges for drains, were made on the Station, and all drains are now well bridged. These bridges, which are 10 ins. wide and from 8 to 20 feet long cost 35 cents per foot.

BUILDINGS AND WATER SUPPLY

All buildings have been upkept during the year, and are in good order. No new buildings have been erected.

The water supply is functioning satisfactorily and no shortage of water has been experienced at any time.

MEDICAL AND HEALTH

Health during the year has been excellent. There were only 21 cases treated in the Government Hospital, viz.:

Relapsed fever cases	Maternity	Wounds & Others	Total
4	9	8	21

There were no admissions to the European Hospital, and only one operation case at the General Hospital. On the suggestion of the Visiting Agent, and with the approval of the Visiting Medical Officer, Dr. Macaskill, the whole area has been brought under the "brush method" of oiling. Oil and labour previously with the spraying method cost \$94.29 per month, and by this method is now down to \$59.50 per month. The whole area is still oiled and will continue to be treated, till the rubber trees are a bit higher.

The medical staff is sufficient for the full 2,000 acres, when opened.

The advice and help given during the year by Drs. Macaskill and Cameron are recorded with appreciation.

GENERAL

Owing to the necessity for retrenchment, Mr. Matthews's services as Assistant were terminated on the return from leave of the Manager. Thanks are due to Mr. Matthews for his assistance.

The assistance and advice of the Officers of the Institute, who have co-operated with the writer on the Station, are also gratefully acknowledged.

The loyal and careful work of the Asiatic Staff is again recorded with appreciation. Mr. D. S. Gardner continued to act as Visiting Agent, and the Manager is also indebted to him for his advice during the past year.

H. W. FOSTON

Manager

Experiment Station

ANNUAL REPORT

FIELD OFFICER. JOHORE

INTRODUCTION

The Field Officer (A. Moore) was stationed in Johore Bahru throughout the whole of 1932, the district covered consisting of Johore, Singapore, and part of Malacca. Through the Officers of the Department of Agriculture constant touch was maintained with conditions on small holdings, but most of the work consisted in advising large estates. The research work of the Institute was closely followed, especially in its application to practical problems, and in order to keep up to date with this and with the development of the Experiment Station the Field Officer paid two visits to Kuala Lumpur of one week each, in March and July respectively.

ADVISORY WORK

This was maintained at a steady level throughout the year, but naturally financial stringency in the planting industry has greatly limited its scope. With practically no development work taking place, advice was usually asked on problems of how to effect economies, rather than how to spend money to advantage.

Visiting work during 1932 is summarized as follows:—

Visits to large estates	...	110
„ „ groups of small holdings	...	13
„ „ officials, business houses, etc.	...	39
TOTAL		212

The advisory letters (not including routine letters) despatched during the year numbered 153. These were mostly in confirmation of advice given during visits, others were in reply to letters of enquiry. As frequently more than one subject was referred to in these letters, the following analysis is appended to show the type and number of questions dealt with in the advisory correspondence:

Botanical—

Budding	...	27
Tapping	...	11

Chemical—

Latex Preservation and Concentration	...	17
Sheet and Crepe Rubber Manufacture	...	19
Machinery, Factories and Smoke Houses	...	20
Grading and Packing of Rubber	...	31

Pathological—

Root Diseases	...	9
Stem and Bark Diseases	...	13
Leaf Diseases	...	8
Animal and Insect Pests	...	11

Soils—

Manuring	...	21
Cover Crops	...	10
"Forestry" Methods of Cultivation	...	15
Soil Conservation and Drainage	...	7

<i>Miscellaneous</i>	...	20
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TOTAL	...	239
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The above are in addition to letters and reports sent by the Research Divisions.

CORRESPONDENCE WITH HEADQUARTERS

It is the practice of the Field Officer to give advice based on information supplied from the Institute, and when necessary special problems are referred direct to the Research Officers. Observations on matters of interest are reported to Headquarters to the Division concerned. The numbers of such reports, together with letters of enquiry addressed to the various Divisions are as follows :

Botanical Division	...	22
Chemical Division	...	73
Pathological Division	...	27
Soils Division	...	23

TOTAL	...	145
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Detailed reports and diaries have been submitted each month to the Director.

EXPERIMENTAL WORK

In co-operation with the estate manager further girth records were taken on a large scale manurial trial covering some 40 acres. This experiment has been under observation for nearly 4 years, and, as the results are interesting and valuable, it is hoped to take further records in 1933. The interest lies in the fact that, although the manured plots have not been treated since May 1930, they not only maintain their lead in growth over the controls but also in rate of growth.

A number of other estates had commenced or were contemplating experimental work of various kinds, but, with the exception of that referred to above, such schemes have mostly had to be abandoned owing to shortage of funds.

SMALL HOLDINGS

The Field Officer pays visits at least once a month to groups of holdings in various parts of the State. These visits are usually in the company of an Agricultural Field Officer of the Department of Agriculture.

Observations are made and conditions generally are noted, while advice and assistance are given where practicable. In the absence of any organisation of small holders, it is difficult to render assistance to the individual. There is, however, evidence that the advice of the Institute frequently reaches the small holder and the smaller Asiatic estates indirectly. The principal channel is by such owners working as labourers on large estates and then applying the ideas they see practised to their own holdings. This is more particularly the case on Chinese rather than Malay holdings, due probably to the fact that Malays do not frequently work on large estates whilst Chinese do. An instance of scientific ideas being carried out on small holdings is in the application of forestry methods. There are of course many cases of small holdings being under a "forest" cover which is simply the outcome of neglect, but a few holdings have been seen where careful selection is being practised and the resulting jungle cover is of the orthodox "forestry" type.

Mouldy Rot is still a serious problem on small holdings since, although its seriousness is being more and more realised, the expense of proper treatment prevents adequate control in these hard times. It might provide an important check on yields in future years, when the recently tapped panels require to be tapped again. Measured by estate standards the tappable bark reserves on small holdings are generally poor, but, as is well known, the small holder taps thin bark or taps very high up the tree and contrives to get rubber from areas which, if they were on estates, would be closed down or abandoned.

There is one direction in which the small holder could benefit himself considerably, and that is in the preparation of cleaner rubber. Improvement of his property by drainage, soil conservation, cultivation, and other such work involving expense, is quite impossible at the present time, but he could improve his product at no cost merely by additional care. During the worst period of 1932 the poorer native rubber was sold at prices which barely paid for transport. Average quality native sheet usually sells at about 2

cents per pound below standard prices, but there is no reason why even with the most primitive equipment the small holder should not produce rubber to sell within 1 cent per pound of the standard sheet price of sheet rubber. All that is needed is care and cleanliness—particularly cleanliness. A great deal of very profitable propaganda work could be done in this direction, if the necessary organisation were available.

GENERAL OBSERVATIONS

Botanical—A number of enquiries have been received on bud-grafting but, as there has been less new planting than in former years, interest in budding has not been so general. Advice has been sought on high budding, budding on large stocks, and on the care of stocks after cutting back. With regard to the latter there has been a considerable improvement in technique, stimulated by the fact that budding on large stocks of trees up to 4 or 5 years old became rather common in 1932.

Interest in various tapping systems has been greater than ever, the objects aimed at being maximum yield with minimum bark consumption, and maximum yield per tapper. Various double cut systems are being tried, notably the "Sunderland" system, introduced from Ceylon and by the end of another year much valuable information will have been accumulated.

Chemical—The year 1932 has seen rapid developments in the manufacture of continuous sheet, four new batteries of machines having been put on the market. Some estates have adapted their old batteries to this type of work, and a general increase in factory efficiency is noticeable everywhere. Smoke houses have improved, and sorting and clipping of sheet has been made more efficient by the introduction of the "Senai Desk"; but attempts to reduce costs still further by introducing baling instead of packing in wooden cases have met with no success.

What promised to be the most important event of the year was the interest taken in the creaming process for concentrating latex. Unfortunately the position with regard to patent rights is not clear, and has put a check on this promising development.

The export of ordinary preserved field latex from Johore has continued, whilst two Revertex plants and a large central factory using centrifugal concentrators are also operating in the State.

The laying of various stretches of rubber roadway in Singapore by the Solar Rubber Processes Co. has been observed, and reports on the roads have been sent to the Chemical Division from time to time.

Pathological—There have been no serious outbreaks of disease during 1932. An attack of *Oidium Heveae* occurred in the Batu

Pahat district in March, but was cut short by the onset of wet weather.

Mouldy Rot still persists on a number of estates and on most small holdings, where at the present time it is almost impossible to enforce treatment.

Root diseases in old rubber are usually neglected, but *Fomes lignosus* in young rubber receives careful attention on most estates. On one estate in Johore valuable work has been carried out under the direction of the Pathological Division, the practical results obtained being of great importance.

A few cases of damage by *Helminthosporium Heveae* (Bird's Eye Spot) have been recorded. Pink disease appears to have been rare, no cases having been reported.

With regard to other pests, White Ants have called for most attention during the year, and improved methods of dealing with them have been practised. In addition a few cases of damage caused by mites, deer, monkeys and grasshoppers have been dealt with.

Soils—The matter of principal interest in relation to soils has been the forestry method of cultivation, which was given much publicity towards the end of 1931. This publicity continued throughout 1932, and several estates are applying such methods more or less intensively. Interest has waned somewhat since it has been realised that the proper development and upkeep of the methods may cost more than clean weeding, the question of whether it is ultimately worth while being often regarded as of secondary importance in these times of financial stringency.

Catch crops on rubber estates, particularly pineapples, are common in South Johore, and are at present more profitable than the main crop—rubber. It is not uncommon for a contractor to agree to plant and maintain rubber for 4 or 5 years in return for being allowed to plant pineapples as a catch crop on the land.

On almost all estates soil conservation work continues to be neglected owing to lack of funds, but, where selective weeding or forestry methods are practised, the results as regards soil erosion are not very serious.

There is no interest being taken in manuring except occasionally in the case of young rubber. The manuring of old rubber areas is definitely uneconomic at the present price of rubber.

CONCLUSION

The continued interest of planters and business houses in the work of the Institute, and the help and information freely given by estate managers are recorded with appreciation.

A. MOORE

Field Officer, Johore

LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH

(CEYLON AND MALAYA)

REPORT FOR 1932

As indicated in the report of the Ceylon Rubber Research Scheme for 1931 proposals were submitted to the Rubber Research Institute of Malaya and to the Rubber Research Scheme, Ceylon by their London Advisory Committees that the two organisations should share the cost of maintenance of the Ceylon Rubber Research Laboratories in London (viz. £2,800 per annum), in order to ensure the continuation of the work carried out for many years on behalf of the rubber planting industry. It was suggested that the control of this research should be vested in a joint Advisory Committee, the constitution of which should be approved by the Boards of the Rubber Research organisations in Malaya and Ceylon, who would also approve the programme of work to be undertaken. It was further suggested that this arrangement should be adopted for a period of three years from the 1st January, 1932 so as to allow the present world crisis to settle down and to afford ample opportunity for the examination and development of the proposals made previously by the Rubber Research Institute of Malaya for (1) a comprehensive scheme of rubber research in the United Kingdom supported by all the interests concerned (including manufacturers) and (2) an international organisation for research on new uses for rubber.

In January 1932 information was received that the Boards of Management in the East were willing to share the cost of the work in London and a joint meeting of the two existing advisory committees was called to arrange for their dissolution and for the appointment of the suggested joint committee. At this meeting it was decided to recommend that the new Committee should be constituted as follows:—

- 1 member nominated by the Colonial Advisory Council of Agriculture and Animal Health
- 1 member nominated by the Malaya Governments
- 1 member nominated by the Ceylon Government
- 3 members representing Malayan planting interests nominated by the Rubber Growers' Association
- 3 members representing Ceylon planting interests nominated by the Rubber Growers' Association
- 2 members representing manufacturing interests nominated by the Research Association of British Rubber Manufacturers,

and the following *ex-officio* members:—

The Director of the Imperial Institute

The Director of the Botanical Laboratories, Imperial College of Science and Technology

The Director of the Imperial Mycological Institute, Kew

The Director of the Rothamsted Experimental Station.

It was also agreed that a Technical Sub-Committee, to supervise the investigations in London and to consider the technical reports received from the East, on the lines of the previous Technical Sub-Committee of the Ceylon Rubber Research Scheme, should be appointed by the Committee.

Owing to the time necessarily involved in obtaining the approval of the constitution of the new committee by the Boards of Management in the East and in the appointment of representatives of the organisations concerned, it was not possible to hold the first meeting until the end of May, 1932. A list of members of the Committee and the additional members co-opted on to the Technical Sub-Committee is given on the inside cover of this publication.

At this meeting it was decided to take advantage of the presence in England of two representatives of the Rubber Research Institute of Malaya (Mr. H. B. Egmont Hake and Lt. Col B. J. Eaton) to confer with them regarding the proposals of the Institute for the establishment of comprehensive rubber research organisations. As a result of the discussion it was agreed that under existing conditions there is no possibility of obtaining any financial support from rubber manufacturers in this country, and that also a considerable time must elapse before the establishment of an International board for research on new uses for rubber could be considered. It was agreed however that the research in this country on behalf of the planting industry should continue to be carried out in co-operation with rubber manufacturers in Europe and America, and with other possible users of latex and raw rubber products.

It was felt that in view of the type of research problem likely to require attention for some time on behalf of the producing industry, it is of the greatest importance in the first instance to ensure that an effective liaison is maintained between the work of the Technical Research Committee of the Rubber Growers' Association and that carried out in London and in the East on behalf of the rubber research organisations of Ceylon and Malaya. As three members of the Advisory Committee are also members of the Technical Research Committee of the Rubber Growers' Association and there is practically a daily interchange of reports and information between the Committee and the Association, no difficulty should arise in maintaining the closest contact. In order however further to facilitate liaison, arrangements were made for the Rubber Growers' Asso-

ciation to be represented on the Technical Sub-Committee by one of its technical consultants (Dr. H. P. Stevens).

The co-operation of the Association has been of great value in the work connected with the processes devised by the staff in London for the preparation of "unvulcanised rubber crumb" a detailed account of which is given in the appendix to this report. Only a limited amount of time and money could be allocated to the study of this problem, and the grant of £350 made by the Rubber Growers' Association rendered it possible to purchase special apparatus and employ temporary assistance so that the experiments could be continued without delay. Copies of a preliminary report on the investigation, which was published in the Bulletin of the Rubber Growers' Association, (November 1932) were forwarded to Ceylon and Malaya for distribution to members of the Boards of Management.

The establishment of a Pension Scheme for the staff had been deferred by the Ceylon Rubber Research Committee in previous years owing to the uncertainty which had existed regarding the continuation of the work in London. The question was reconsidered by the new Committee in view of the altered arrangements as a result of which a scheme was approved, under which payments of 5% of salary by the staff and a like contribution from the Committee are applied in paying premiums on Endowment or Deferred Annuity Policies maturing at 60 years of age. The Scheme took effect from the 1st January, 1932.

No alterations were made in the permanent technical staff during the year. In view of the shortage of staff in the Chemical Division of the Rubber Research Institute of Malaya, the Committee offered the services of one of the chemists in London for a period of say one year in order to help the Board to overcome any temporary difficulties in dealing satisfactorily with the number of important chemical problems requiring attention under the existing conditions of the rubber industry and also with a view to improving liaison between the work in London and in the East. This offer was however not accepted.

As from 1st May 1932, the Committee took over from the Rubber Growers' Association the secretarial duties which they had previously carried out on behalf of the London Advisory Committee of the Rubber Research Institute of Malaya and the work as London agents of the Institute for which a payment of £250 a year had been made to the Association. These new arrangements involved a considerable addition to the office expenses and it was soon necessary to appoint an additional typing and general assistant. It was suggested to the Rubber Research Institute that some special payment should also be made to the Committee for these services

but these representations had not met with success by the close of the year.

Mr. H. B. Egmont Hake, Member of the Board of Management, Rubber Research Institute, Lt. Col. B. J. Eaton, Director of the Rubber Research Institute of Malaya and Mr. R. K. S. Murray, Mycologist, Rubber Research Scheme, Ceylon, attended meetings of the Committee whilst in London. Lt. Col. Eaton and Mr. R. O. Bishop, Head of the Chemical Division of the Rubber Research Institute also paid several visits to the laboratories in connection with various questions relating to the work in progress in London and in the East. These conferences should prove of the greatest value both to the staff in London and in the East and may, it is hoped, lead to a fuller appreciation and utilisation by the Rubber Research Institute of Malaya of the services which can be rendered by the London Advisory Committee and its staff.

The expenditure incurred in connection with the work in London during the year amounted to £2,618.1.1. After allowing for liabilities outstanding at 31st December 1932, there was an unexpended balance in London of £150.0.0. and there was also a balance of £118.15.4. held on behalf of the Rubber Research Institute of Malaya from the funds supplied by them to meet expenditure incurred on behalf of the Institute.

Particulars of the investigations completed and in progress during the year are given in the appendix. The following reports were forwarded to Ceylon and Malaya:—

1. *Clone Rubber*.—A series of 190 samples was received from the Rubber Research Institute of Malaya for tests on the quality of the rubber from the clones available on Pilmoor Estate.

2. *Effect of paramitrophenol and gambier on ageing properties of sheet rubber*—12 samples were received from the Rubber Research Scheme, Ceylon in connection with the work of Mr. O'Brien on the most economical method of drying sheet rubber.

3. *Crepe from coagulum treated with hot water*:—with a view to preparing in Ceylon a uniform type of soft rubber.

4. *Standardisation of methods of testing*:—investigations in conjunction with the Proefstation at Buitenzorg, Java and the Rubber Research Institute of Malaya.

5. *Examination of latex preserved with ammonia*—reports forwarded at intervals throughout the year.

6. *Air-dried sheet*

7. *Up-river fine Para*

No report dealing with the detailed examination of the effect of 'reclaim' on the manipulation of rubber was issued as it was considered preferable to defer publication in the East until a paper

could be read before the Institution of the Rubber Industry where the matter could be discussed fully with rubber and reclaim manufacturers. Arrangements have been made for a paper on the subject to be read at a meeting of the London section of the Institution in March 1933 after which it is proposed to prepare for circulation at an early date a popular summary of the paper and of the views expressed during the discussion.

During the year an investigation of over 300 estate samples from Ceylon received in connection with the detailed study of variability of Ceylon rubber has been in progress. This investigation is nearly completed and a report will shortly be forwarded to the Boards of Management. A large amount of interesting data has been obtained: the results are being analysed and proposals for action on estates producing abnormal rubber are under review.

As indicated above special attention has been devoted to devising and developing processes for the preparation of unvulcanised rubber crumb ("powdered rubber") and to studying the possibility of its use in the rubber and other manufacturing industries in Europe and America. Already over 50 samples have been supplied to firms and organisations interested in the product. The replies so far received indicate that this material is not likely to be employed successfully in the rubber manufacturing industry except for special purposes. A few preliminary reports have been received from possible users in other industries and some of these are definitely promising. The work is still in progress and not yet ready for publication.

After discussion with the Director of the Rubber Research Institute of Malaya, a programme of research in London for the years 1932—1935 was prepared and forwarded to Ceylon and Malaya for approval. The principal aims of the work in London may be classified as follows:—

1. Co-operation with the staff in the East with regard to the following problems—

- (a) The preparation of rubber with properties which render it more suitable for particular purposes.
- (b) The effect on the suitability of rubber for manufacturing purposes of economies in preparation.
- (c) The preservation, concentration, transport and general suitability of latex—
- (d) The effect of agricultural factors on the quality of rubber, e.g. clone rubber.
- (e) The effect of storage on the quality of rubber prepared by different methods.

2. A study of the effect on quality of factors which have become important owing to recent developments in the rubber manufacturing industry e.g.

- (a) The relation of serum substances to "scorching"
- (b) The effect of storage under a variety of conditions on plasticity
- (c) The effect of serum substances on the vulcanisation of accelerator mixings
- (d) The effect of degree and type of oxidation of raw rubber on the tensile strength and ageing properties of vulcanised rubber.

3. Arrangements with individual manufacturers for trials of special types of rubber viz :

- (a) Rubber crumb
- (b) Boiled rubber
- (c) Nitrite rubber
- (d) Creamed latex.

4. Co-operation with the Research Association of British Rubber Manufacturers in the production of rubber for special purposes, e.g. ebonite.

5. Collection of information concerning the utilisation of rubber and latex with a view to ensuring that new developments (particularly those outside the rubber manufacturing industry) are receiving the necessary attention as regards the suitability of rubber at the producing end.

P. J. BURGESS
Chairman

J. A. NELSON
Secretary

Imperial Institute

South Kensington, S.W. 7

16th March, 1933

APPENDIX TO ANNUAL REPORT OF LONDON ADVISORY COMMITTEE

FOR 1932

TYPE OF RAW RUBBER REQUIRED BY MANUFACTURERS

Recent developments in the rubber manufacturing industry have led to the expression of a variety of views, in some cases contradictory, as to the types of raw rubber best suited to manufacturers, with the result that the Research Organisations in the rubber growing industry have been handicapped considerably in their work on the preparation of rubber of the required quality.

A memorandum was accordingly prepared on the subject, based on the experience derived by the staff of the Committee from personal contact with individual manufacturers and on information obtained as a result of previous investigations of the Ceylon Rubber Research Committee. This memorandum was submitted to a large number of manufacturers in Europe and America and to the Research Association of British Rubber Manufacturers, and from the data furnished it was possible to formulate a practical scheme of investigation with a view to satisfying most of the individual requirements of manufacturers.

The three principal requirements of manufacturers appeared to be :—

1. Rubber which is essentially reliable and uniform during manipulation, vulcanisation and during subsequent use.
2. Uniformly hard, soft and very soft rubber with distinctive differences in appearance to avoid confusion and consequent difficulty during manufacturing operations.
3. Rubber with little tendency to absorb water.

These particular requirements have been under investigation for some time, and the progress made during the year is summarised below.

(1) UNIFORMITY

A detailed study of the variability of rubber from most estates in Ceylon was nearly completed at the close of the year. The investigation has involved a considerable amount of work owing to the large number of samples (over 300) and the different properties which required examination. The samples supplied by some of the estates differ markedly from the average, but definite conclusions cannot be drawn until the investigations have been completed and the results analysed. They are expected to give full information concerning the variability now experienced by manufacturers using

Ceylon rubber, and it is proposed to supplement the investigation with a study of the methods of preparation adopted on the estates supplying abnormal rubber with a view to modification, if necessary, in the interests of the uniformity of Ceylon rubber.

(2) MANIPULATIVE PROPERTIES

The experiments so far carried out on the preparation of soft rubber may be classified under the headings—(a) Appropriate chemical treatment of latex (b) Hot water treatment of coagulum (c) Oxidation of rubber after disintegration into a finely divided form. In addition, experiments have been carried out on allied problems connected with (d) changes in plasticity on keeping, and (e) the use of reclaim to improve the manipulative properties of crepe and sheet.

There is not the same demand for hard as for soft rubber, and the study of the methods of preparing hard rubber was accordingly deferred. Proposals were communicated to the Research Officers in Ceylon and Malaya for their co-operation in work on the subject during 1933.

(a) The method of preparing soft rubber by a chemical treatment of preserved latex without oxidation referred to in the report for 1931 was further developed during the year and samples obtained from fresh latex were forwarded by Mr. O'Brien for examination in London. Although these were found unsuitable for most purposes for which crepe or sheet are employed, some manufacturers are interested in the rubber and claim that it gives good results when treated by special methods. A consignment is being prepared in Ceylon for technical trials.

(b) In view of the promising results of the previous experiments on the effect on plasticity of immersing the coagulum in hot water further samples were examined and the results confirmed that this treatment causes crepe to be uniformly soft and easily masticated. Although crepe prepared by this method is not softer than occasional consignments of first grade crepe and sheet it should be uniformly plastic and, if this method of preparation were generally adopted, the difficulties now caused by occasional consignments of hard crepe should be avoided. A consignment of the rubber is also being forwarded from Ceylon for technical trial.

(c) Considerable interest is being displayed in Europe in "softened" rubber prepared by the oxidation of disintegrated rubber (E.P. 368902, 1931 Ungar and Schidrowitz). Samples of this rubber which were examined were found to be extremely soft and they extruded easily with little recovery of shape. The results of the vulcanising and ageing tests so far carried out indicate that the conditions of oxidation may affect the relation between the softness

of raw rubber and the properties of the vulcanised product. The investigation is being continued.

(d) One of the greatest difficulties in producing a uniformly hard or soft rubber is that rubber may change on keeping. It was previously found that rubber tends to become hard in the complete absence of moisture and that softening is induced by oxygen and accelerated by increasing the temperature. Further investigations shewed that the serum substances tended to prevent its softening in air and that the accessory substances soluble in acetone had the opposite effect. This work has so far served to define the factors affecting the changes in the hardness of rubber on keeping and they indicate that a definite balance of water-soluble and acetone-soluble non-rubber accessory substances may be necessary to produce a rubber which does not change on keeping. Most rubber becomes hard on keeping in Europe so that a reduction in the amount of water-soluble substances should be an advantage from this point of view. This investigation is being continued.

(e) The merits of reclaim have received a considerable amount of publicity in the technical press but little scientific evidence has been published to support these statements. A wide selection of grades of reclaim mixed with raw rubber with and without compounding ingredients was accordingly submitted to the following tests, viz. mastication, power consumption, recovery, deformation and extrusion. It was found that the advantages of adding reclaim to the mixtures are not as definite as has been suggested. The most expensive grades of reclaim hindered the mastication, extrusion and deformation of rubber, but the cheapest grades effected a small improvement.

An important advantage of reclaim demonstrated by these experiments is that mixtures of rubber and reclaim do not recover from deformation to the same extent as rubber alone. On the other hand oxidised rubber behaves similarly to reclaim in respect of recovery from deformation and is much superior as regards ease of deformation generally. These results are being given wide publicity in order that manufacturers may have an opportunity of discussing the results obtained.

(3) WATER ABSORPTION OF RUBBER

A study has been made of the amount of water absorbed by the comprehensive range of samples obtained from Ceylon for tests on uniformity. The investigation was nearly complete at the end of the year. It was found that some samples of rubber absorbed much more water than others under fixed atmospheric conditions and proposals for further work have already been forwarded to the East.

Co-operation was maintained with the Research Association of British Rubber Manufacturers and the Electrical Research Associa-

tion in their joint investigations on ebonite. Their work will eventually involve a study of the effect on the quality of ebonite of rubber prepared so as to absorb as little moisture as possible.

RUBBER CRUMB

The cost of rubber manufacturing is high relative to that of raw rubber. Consequently cheap raw rubber is not as helpful as the grower would desire in promoting the production of cheap rubber articles. A method of eliminating the need for heavy machinery would be to prepare rubber in the form of powder so that it can be mixed with vulcanising and compounding ingredients merely by shaking, after which it can be pressed into moulds and vulcanised under pressure so that the particles amalgamate together to the shape required. A chemical process of preparing rubber crumb from latex has been devised by the staff in London and is being developed by Mr. O'Brien in Ceylon. Mechanical methods of preparing rubber crumb from latex or dry crepe have also been devised by the staff in London. Applications for British patents have been made (Nos. 3,198/32, 11,717/32 and 34,181/32 respectively), but it is not proposed to restrict the use of these processes. The work in London has been concentrated on the mechanical process. The particles obtained by this method vary from 1/32 inch diameter to a fine dust. Even if the fine dust were separated from the coarser particles by sieving, the finest particles would still be much larger than the rubber particles in latex. Fortunately sulphur and a number of accelerators, antioxidants, colouring materials etc. are soluble in rubber, and it has been found that there is a wide range of materials which, after mixing with rubber crumb by the simplest means, form on vulcanisation excellent products.

The preliminary experiments shewed that the principal difficulty in using the crumb is that when it is mixed by stirring with finely divided mineral powders such as zinc oxide or carbon black the powders coat the particles of rubber and interfere with their amalgamation during vulcanisation. The amount of mineral powder which can be incorporated with rubber crumb without seriously interfering with the strength of the vulcanised product depends upon the size of the particles, temperature, pressure and rate of vulcanisation. No difficulty is experienced with 5 parts of zinc oxide per 100 parts of rubber using an ordinary screw press and vulcanisation temperatures as low as 126°C.

The experiments of the London staff have also shewn that the crumb can be used to produce:—

- (a) Artistic mottled surfaces.
- (b) A new type of sponge rubber.
- (c) Rubber-covered fabrics without rubber solvents or latex.

There are many other directions in which a use may be found for crumb powder and a promising line of investigation is the direct chemical treatment of the crumb or solution of the crumb in suitable organic materials such as asphalt. However cheaply rubber crumb can be made, and whether it be made from fresh latex in the East or from dry rubber in Europe and America, it is necessary to assume that it will be at least slightly more expensive than crepe or sheet. The price and the limited extent to which it can be compounded will restrict the use of the crumb for purposes where crepe or sheet are now employed, but there are other purposes for which the granular form is of vital importance, and should be of value in extending the market for materials containing rubber.

EXPERIMENTS INITIATED IN THE EAST

(a) *Clone Rubber.* In continuation of the previous investigation of clone rubber in association with the Proefstation West Java at Buitenzorg, two further samples from well-known clones were received from Java for examination. On the whole the results of the tests were similar to those obtained previously, but it would not be possible to draw general conclusions on tests on clone rubber until the samples can be prepared from mature trees by the methods officially recommended for estate crepe or sheet: these should however be available shortly.

A set of 190 samples of sheet was received from the R.R.I. Malaya, each representing the product of a single day's tapping during August, October and December, 1931 of six clones and a control block on the Pilmoor Estate. Composite samples from each clone for each month vulcanised quickly and were satisfactory with regard to plasticity, tensile strength and ageing. The results of hardness and rate of vulcanisation tests on individual samples shewed that they were satisfactorily uniform.

(b) *Air-dried sheet.* During the year further samples were received from Mr. O'Brien in connection with the experiments carried out in Ceylon on the most economical method of drying sheet rubber. The examination of these samples confirmed the previous conclusion that although paranitrophenol, which was used to prevent mould, had little effect on the ageing properties of sheet dried in smoke, it had a harmful effect on sheet dried in air. There was however little tendency for mould to develop in the absence of paranitrophenol when the sheet was dried at temperatures of 100°F and over.

It is of interest that sheet dried in warm air which is being prepared in Malaya without paranitrophenol does not cause any difficulty as regards mould. Sheets received from manufacturers in the United Kingdom were of good appearance, but no samples pre-

pared under scientific supervision with a smoked sheet control for comparison have been sent for examination and it is not possible to draw general conclusions regarding the quality of this form of sheet from Malaya. One of the above samples received from a rubber manufacturer vulcanised unsatisfactorily in a popular type of accelerator mixing and the manufacturer stated that all the air-dried sheet from this estate behaves similarly.

It is evident (1) that the quality of air-dried sheet prepared in Malaya requires study and (2) that it is undesirable to use paranitrophenol to prevent the development of mould in unsmoked sheet.

(c) STANDARDISATION OF METHODS OF TESTING.

Attention has frequently been called to the advantages to be derived from using identical vulcanisation tests in rubber-sulphur mixings at the official research stations in the East and London. In accordance with the arrangements made at the conference of rubber technologists in Java in 1929 investigations were carried out during the following year in conjunction with the Proefstation at Buitenzorg with a view to determining the extent of the agreement between results of tests on a sample of rubber when the same methods were employed in Java and London. In view of the differences in the results obtained, the investigation was extended and further duplicate tests carried out. The principal differences now found are (1) a slightly higher temperature (0.3°C) is required in London to obtain the same chemical and physical state of vulcanisation as in Java; this may be due to a slight change in the rubber during transit from the East and (2) tensile strengths are lower in London than in Java. Continuation of the work is dependent upon the extent to which the Research Stations are able to devote time to the subject, having regard to the demands of other important problems under investigation. Co-operation in this matter with the Rubber Research Institute of Malaya was under discussion at the close of the year with members of the technical staff of the Institute on leave in this country and it is hoped that it may be possible to arrange for the results of vulcanisation tests in Malaya and London to be reported on similar lines.

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